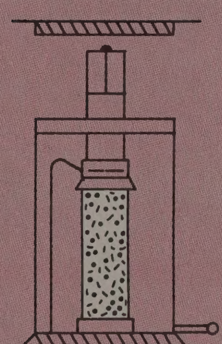
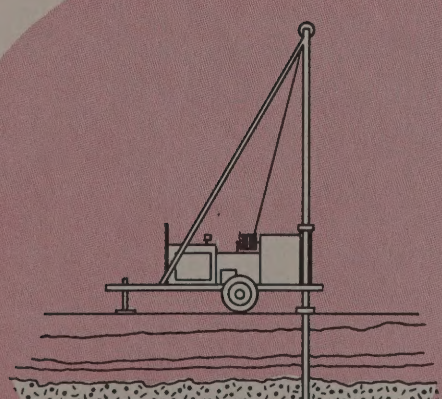
STATE OF NEW YORK
DEPARTMENT OF TRANSPORTATION

RAYMOND T. SCHULER, COMMISSIONER

EXCELSIOR

SOIL MECHANICS BUREAU





TUNNEL COST STUDY
ROCHESTER OUTER LOOP
SCOTTSVILLE ROAD TO
LEHIGH VALLEY RAILROAD
MONROE COUNTY, PIN 4040.20-101

SM 238b (1/73)

MEMORANDUM
DEPARTMENT OF TRANSPORTATION

DATE July 12, 1973

SUBJECT TUNNEL COST STUDY
ROCHESTER OUTER LOOP, SCOTTSVILLE RD. TO LEHIGH VALLEY R.R.
MONROE COUNTY, PIN 4060.20 101

FROM Lyndon H. Moore, Soil Mechanics Bureau, Room 103, Bldg. 7A

TO R. N. Kemp, Structures Subdivision, 6th Floor, Bldg. 5

CC E. P. Perry, Regional Director of Transportation, Region 4
Wm. P. Hofmann, Technical Services Subdivision, Room 210, Bldg. 7A

In accordance with your request at a meeting on March 22, 1973, Jerry B. Howe, Associate Engineering Geologist, of this Bureau has prepared the following Tunnel Cost Study Report for the subject project. The cost summaries reported are based upon ideal subsoil and rock conditions that will not present unusual construction problems. A detailed design based upon extensive subsurface exploration and testing may result in actual construction costs considerably higher than those reported.

During the cost study other important factors became apparent that should be considered in any feasibility study of the tunnel design. These factors are described in Section K of the report. Among the most important is the severe operational problems caused by the proximity of the Scottsville Road Interchange to the west portal on all alternates. The driver will have to cope with interchange traffic movements without adequate signing under rapidly changing light conditions.

The need for massive ventilation buildings about 60 feet high will present an aesthetic and air pollution problem. On the southern alignment these buildings will be in the middle of the park.

Maintenance and operation costs were also analyzed and will approach $500,000 per year. (Sect. I.)

LHM:MR

MEMORANDUM
DEPARTMENT OF TRANSPORTATION

DATE July 12, 1973

SUBJECT TUNNEL COST STUDY
ROCHESTER OUTER LOOP, SCOTTSVILLE RD. TO LEHIGH VALLEY R.R.
MONROE COUNTY, PIN 4040.20 101

FROM Lyndon H. Moore, Soil Mechanics Bureau, Room 102, Bldg. 7A L.H.M.

TO R. N. Kamp, Structures Subdivision, 6th Floor, Bldg. 5

CC B. F. Perry, Regional Director of Transportation, Region 4
Wm. P. Hofmann, Technical Services Subdivision, Room 210, Bldg. 7A

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LHM:MR

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MEMORANDUM
DEPARTMENT OF TRANSPORTATION

DATE June 30, 1973

SUBJECT TUNNEL COST STUDY
ROCHESTER OUTER LOOP, SCOTTSVILLE RD. TO LEHIGH VALLEY R.R.
MONROE COUNTY, PIN 4040.20 101

FROM Jerry R. Howe, Associate Engineering Geologist

TO Lyndon H. Moore, Director

A. INTRODUCTION

During the Spring of 1973 at the request of Mr. Robert N. Kamp of the Structures Design and Construction Subdivision, the Soil Mechanics Bureau coordinated an effort to prepare cost estimates for two methods of tunneling for each of two separate routes carrying the Rochester Outer Loop beneath the Genesee River, Red Creek and the Genesee Valley Park. This report presents costs of tunnel alternates only. Additions and subtractions involved in both these or other alternates will be outlined and discussed elsewhere. The cooperative effort involved personnel from the Structures Design and Construction Subdivision, Region No. 4 and the Federal Highway Administration. Mr. James D. Washington, Tunnel Specialist, FHWA contributed extensively to this study and guided the project to successful completion.

The original request for this work demanded a high and low range of costs for each of the two tunneling methods. During the course of the study it was determined that unknown natural conditions mentioned later in this report could increase

tunneling costs three-fold. It was therefore decided to estimate only the low range cost for each method and to base the estimate on optimistically favorable rock and water conditions.

In order to progress the study satisfactorily it was decided to intensively examine Alternate Route "A" and then "plug in" the figures obtained into the two tunnel alternates proposed for Alternate Route "B". The differences in cost reflect the difference in tunnel length and the pumping and ventilation requirements. It is assumed that other requirements remain approximately the same.

Every effort has been made in the report to impart the fact that highway tunnels are massive and complicated structures and not merely "holes in the ground". Figures and Plates have been provided in order that those interested may gain some insight into tunnel design and construction. The Plates are somewhat diagrametrical. Construction drawings would be intricately more detailed.

B. SUMMARY

Alternate Route "A"	Estimated 1973 Cost*
Tunnel Alternate One (Cut and Cover)	$76,034,996
Tunnel Alternate Two (Driven)	$75,917,007
Alternate Route "B"	
Tunnel Alternate Three (Cut and Cover)	$63,109,030
Tunnel Alternate Four (Driven)	$67,647,136

*With a few exceptions all tunnel item costs were obtained from actual bid prices submitted on tunnel projects between the years 1966 and 1969. Using a 1967 base equal to 100, the composite index of prices for federal-aid highway construction was at approximately 140 at the beginning of 1973, or an increase averaging 6.6 percent per year. For the purposes of this study it appears conservatively reasonable to assume that prices for items used in this estimate, on the average, have increased a like amount. For this reason, the estimate of costs included in this report reflect a 6.6 percent per year inflation surcharge for the years 1970 (the year after the last bid prices used in the estimate were opened) through 1973. It should be emphasized here that the cost estimates are accurate only if a tunnel contract were let in 1973. Each additional year will undoubtedly incur additional costs.

C. DESIGN CRITERIA

The Highway Design Class of the Rochester Outer Loop is U1 Free. According to the Highway Design Manual of the New York State Department of Transportation, a roadway of this classification has either three or four travel lanes, each 12 feet in width, a left shoulder width of six feet and a right shoulder width of 12 feet. In order to keep construction costs to a minimum in this study, a tunnel section was chosen which would allow three travel lanes. The section is sub-standard however, in that it does not provide shoulders on either side. Again, this was done to minimize costs. Other criteria considered in the design of the alternates studied by this report include the following.

1. Maximum allowable grades shall be five percent. This is greater than the standard allowable four percent but is necessary in order that the tunnels meet end points.

2. Minimum clearance in the tunnel section shall be 14' 6".

3. As nearly as practicable, the same class of service shall be provided for all alternates.

4. Ventilation buildings shall be designed such that they comply with the flight line clearance requirements for Monroe County Airport.

5. Damage to Genesee Valley Park shall be kept to an absolute minimum.

6. That portion of Genesee Valley Park involved in construction of the alternates shall be restored, as nearly as practicable, to its original condition.

7. Maximum curvature shall be 5 degrees.

8. Normal flow and traffic shall be maintained in the Genesee River, Red Creek and the Barge Canal.

9. Measures shall be provided to minimize contamination of existing waterways.

D. TUNNELING METHODS

Highway tunnels can be classified into two very broad categories: (1) tunnels constructed from the surface, and (2) tunnels constructed by mining methods.

The first category deals with the two types of tunnels where the major construction operations are accomplished from the surface; namely; cut-and-cover tunnels and trench tunnels. The latter is used exclusively for subaqueous work.

In the trench method, prefabricated tunnel sections are constructed in shipyards or dry docks, (See Fig. 1 and 2), floated to the tunnel location, (See Fig. 3), sunk into a dredged trench, (See Fig. 4), joined together underwater, (See Fig. 5), and the trench backfilled. Although a trench tunnel is usually much less costly than one constructed by the use of a shield and compressed air, the method is not adaptable to every river crossing. Only when subsurface soil conditions, river current, volume and character of river traffic, availability of construction facilities, and type of existing waterfront structures are favorable does the trench method offer an economic advantage over alternate construction methods.

At the site of these studies the lack of nearby shipyard or dry dock facilities and the need for extensive deepening of the Genesee River to accommodate the floating of prefabricated tunnel

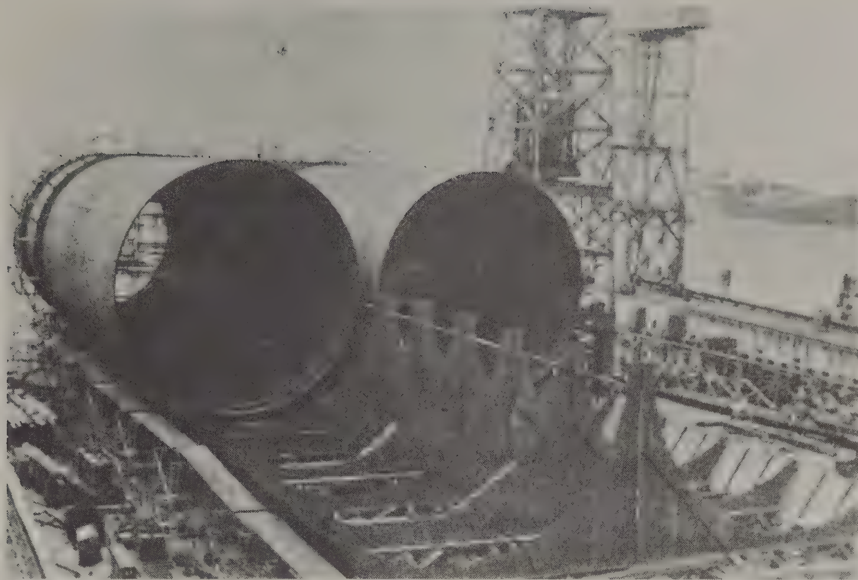


Figure 1

Prefabricated tunnel section under construction at shipyard (Baltimore Harbor Tunnel, Maryland). Tunnel section accomodates two 11 foot wide traffic lanes in each of its two tubes.

Figure 2

Completed 300 foot-long tunnel section being launched from shipway. (Baltimore Harbor Tunnel, Maryland).

Figure 3

Prefabricated tunnel section being towed from shipyard to project site for outfitting prior to sinking. (Chesapeake Bay Bridge-Tunnel, Virginia). Single tube tunnel section carries two 12 foot wide traffic lanes.

Figure 4

Artist's drawing of prefabricated tunnel section being sunk into prepared trench. (Trans-Bay tunnel for Bay Area Rapid Transit System, San Francisco, California).

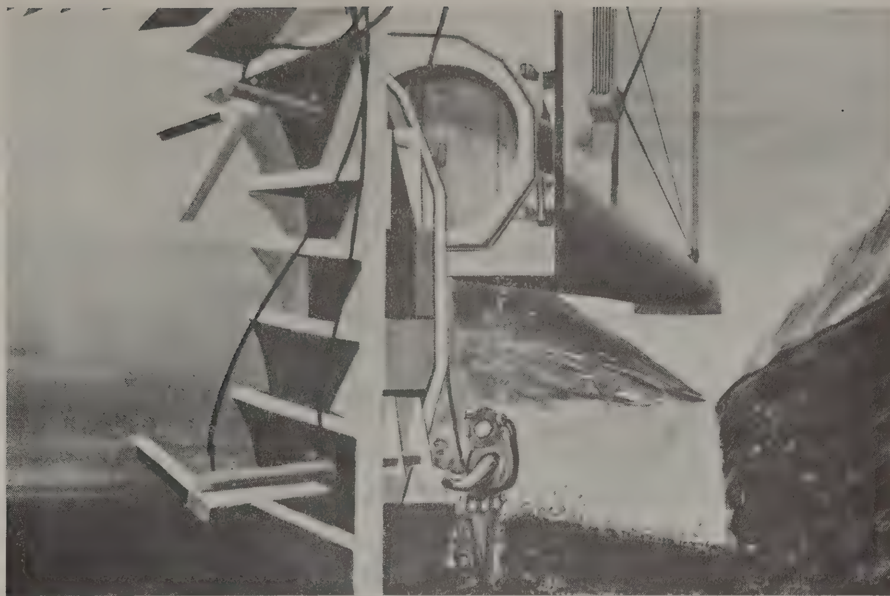


Figure 5

Artist's drawing of underwater joining of prefabricated tunnel sections (Trans-Bay Tunnel, BART, California).

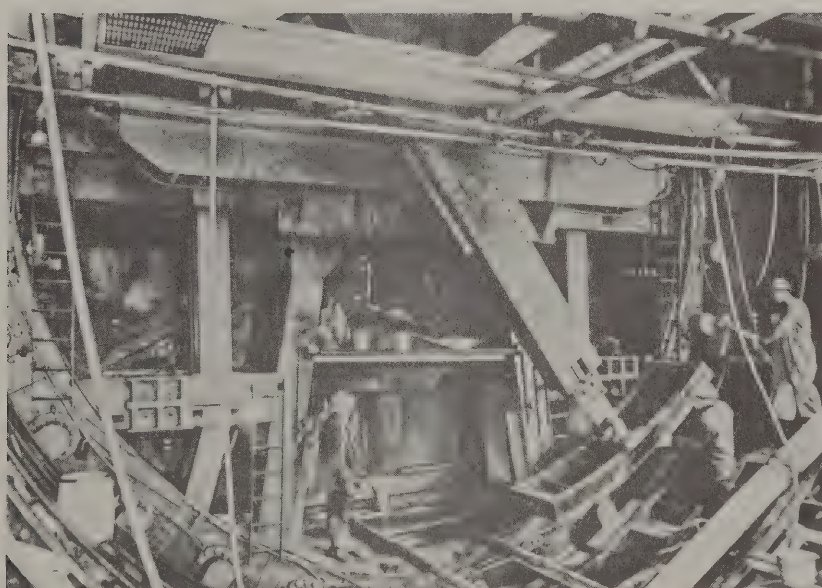


Figure 6

Rear view of tunnel shield operating in compressed air atmosphere. Workers in the lower right are erecting tunnel lining under protection of shield (Lt. William F. Callahan, Jr., Tunnel, Boston, Massachusetts). Completed bore carries two 10'-9" traffic lanes.

sections involve cost penalties of such magnitude that the trench method is considered not feasible at the subject locations.

A comprehensive study of a tunnel constructed by cut-and-cover methods was made. The details of this construction method are contained in Section E under the heading of "Alternate One".

The second category of tunnel classification refers to those tunnels which are constructed without removing the overlying rock or soil. Usually this category is sub-divided into two groups according to the required construction method. These methods are named to reflect the overall character of the material to be excavated, i.e. hard rock and soft ground. In most cases, hard rock tunneling is less expensive than soft ground tunneling. From the limited subsurface soil information available in the study area it appears that soft ground tunneling should be avoided at this site. Since the tunnel is located well below ground water level and the soft ground is likely to need immediate and heavy support during construction, extremely expensive soft ground tunneling techniques (most likely shield and compressed air, see Fig. 6) would be required. Further complications would be encountered with soft ground tunneling in the study area because the construction of a tunnel of the required size beneath the Genesee River would involve a "mixed face" (a combination of soft ground and hard rock) heading. Blasting would be required to remove the rock. The maintenance of necessary air pressure and

adequate support in the excavation during blasting operations results in a hazardous and extremely costly operation. Therefore, the studies were directed to alternate schemes which would not include a soft ground tunnel section.

A study was made of a tunnel constructed by mining methods for those portions of the tunnel located in rock, with connections on each end constructed by cut-and-cover methods. Details of this study are included in Section F. under the heading of "Alternate Two."

In recent years, tunnel boring machines have been developed for rapid excavation in rock, (See Fig. 7). The possible use of such a machine at the study area was investigated. To accommodate a three-lane roadway configuration would require a machine of unprecedented size; approximately 49 feet in diameter. Such a machine is estimated to cost about nine million dollars. *
It is not considered reasonable to expect a contractor to be able to capitalize the cost of this expensive, single purpose, highly sophisticated piece of machinery on a project of this size. In addition, the time delay involved in designing and constructing a suitable tunnel boring machine could reduce the savings in

* Cost estimated from "rule of thumb" formula developed by the U.S. Bureau of Reclamation in 1969.

construction time (should the machine perform satisfactorily) to a point where overall progress on the project would not be materially affected. For these reasons, all rock tunnel cost estimates are based on classical excavation methods, without consideration of the use of boring machines.

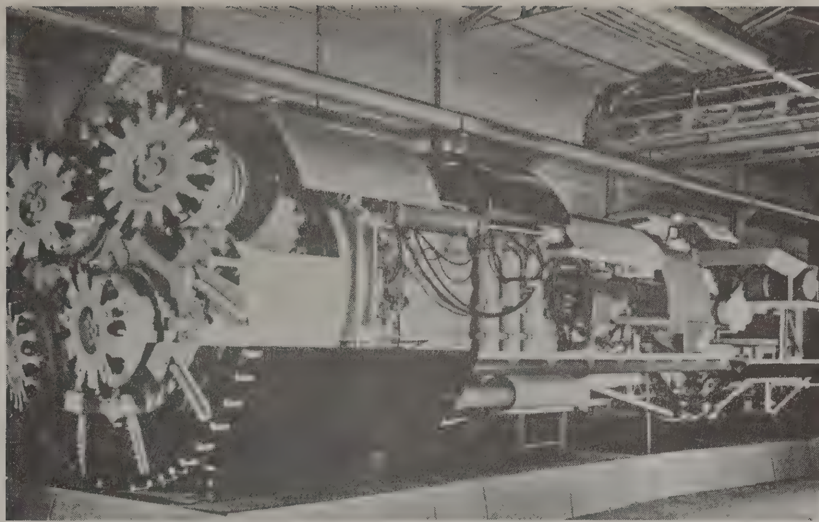


Figure 7

Hard rock tunnel boring machine manufactured by Habegger Ltd., Thun, Switzerland. Machine can bore a tunnel from 10'-6" to 11'-9" in diameter. Material handling and tunnel support erection systems not shown in photograph.

Figure 8

Driving steel sheet piling to support the sides of the excavation (New River Tunnel, Florida). Note man on top of sheet pile in upper portion of photograph.

E. ALTERNATE ONE

The most common method of tunnel construction in urban areas is the cut-and-cover method. As the name implies, the method consists of excavating an open cut (See Fig. 8 and 9), building the tunnel within the cut (See Fig. 10), and backfilling over the completed structure. Under ideal conditions this is the most economical method of constructing tunnels located at shallow depths. However, at the study location the maintenance of surface traffic (rail, vehicular and pedestrian) and maintaining the flow of the Genesee River and Red Creek will add a substantial amount to the construction costs.

In order to make the Genesee River Crossing it will be necessary to build the tunnel in two stages. The first stage will consist of constructing the tunnel across approximately one half the river width (See Fig. 11). Upon completion of Stage 1, the tunnel will be backfilled, the sheeting and bracing removed, and the river flow diverted over the completed section. Stage 2 construction will be similar to Stage 1, with the excavation occupying the remaining portion of the river crossing. In order to maintain river flow and to eliminate possible flooding upstream from the river crossing it will be necessary to widen the Genesee River to the east while the west cofferdam is in existence, and then to widen the river on the west side during the construction of the tunnel on the east (See Plate One).

Figure 9

Completed excavation for cut-and-cover tunnel. (Center Leg Mall Tunnel, Washington, D.C.). Excavation supported by soldier beams and wood lagging held in place by tie-back beams.

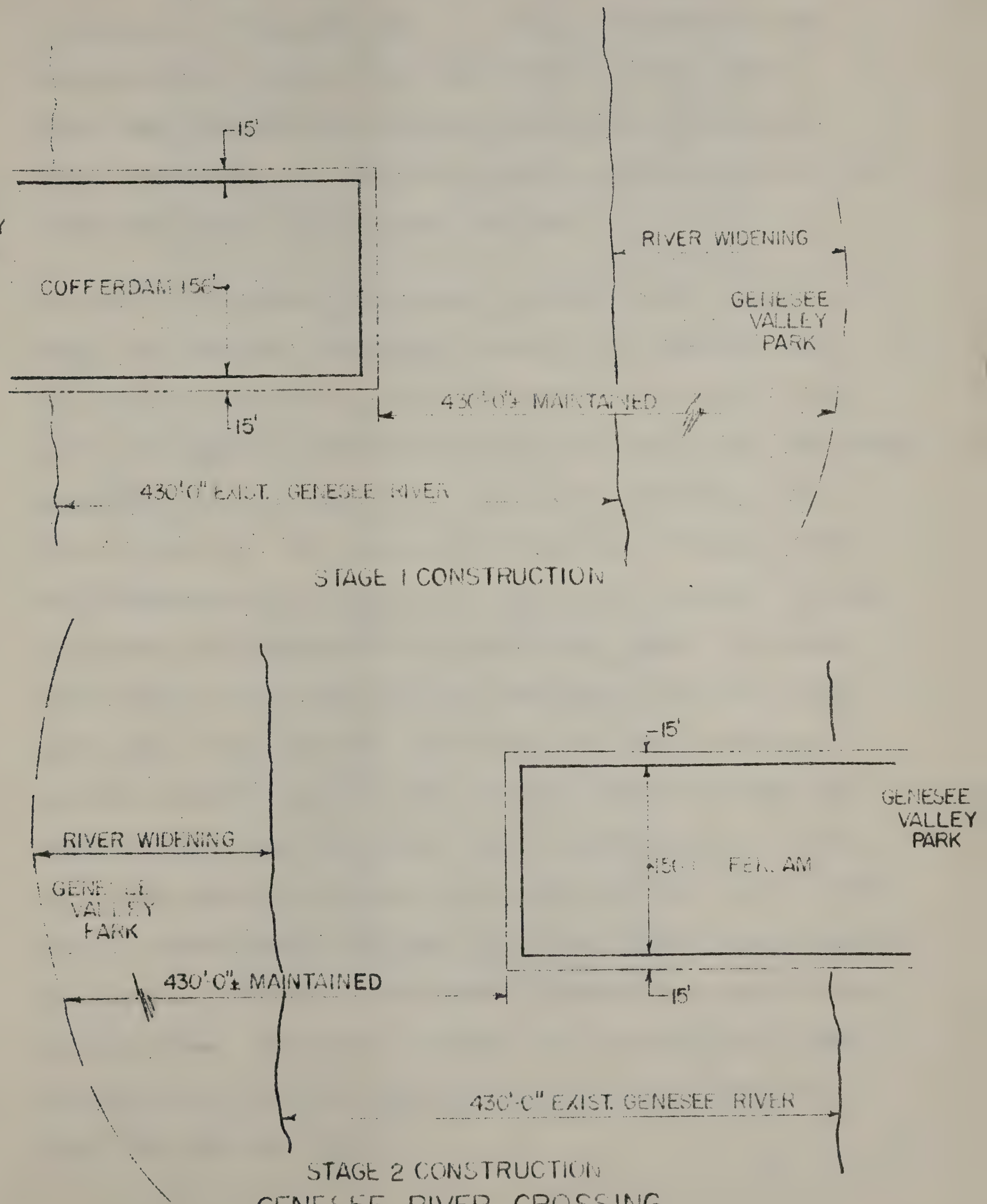
Figure 10

Placing reinforcing bars for bottom slab and walls of tunnel structure. (Center Leg Mall Tunnel, Washington, D.C.). Dark area in center of photographs is membrane waterproofing for underside of tunnel.

Figure 11

Stage 1 construction of river crossing for cut-and-cover tunnel. (Harvey Canal Tunnel, Louisiana). Note provisions in the foreground for maintaining railroad and street traffic.

GENESEE VALLEY PARK
ROCHESTER, NEW YORK



GENESEE RIVER CROSSING
ROCHESTER OUTER LOOP
ALTERNATE ONE

Del.: J.S Campoli 6/4/73

Red Creek presents another somewhat formidable obstacle to the construction of Alternate One. It will be necessary for the construction to proceed an optimum distance from Red Creek, divert Red Creek over the finished construction, complete the tunnel construction at the former location of the creek and finally return the creek to its original location.

As pointed out earlier, the tunnel is located below ground water table. An extensive dewatering system will be required during the construction period so that the tunnel can be built "in the dry". The physical and financial hazards of large scale dewatering operations are well known to the engineering community. (See Figs. 12 and 13). The University of Rochester's Nuclear Center at the eastern end of this project is of prime concern. In order to minimize the lowering of the ground water table, the tunnel cross-section is arranged with the ventilating air ducts at the same level as the roadways. (See Plate Two) This layout of air ducts permits the shallowest possible excavation under the Genesee River, resulting in the lowest possible grades. A four foot thick protective blanket is provided over the tunnel section where it passes under the river. The river underclearance controls the vertical alignment of the tunnel, yielding the profile shown on Plate Three. Horizontal alignment is controlled by the need to tie into the existing completed portion of the Outer Loop. (See Plate Four and Four A).

Figure 12

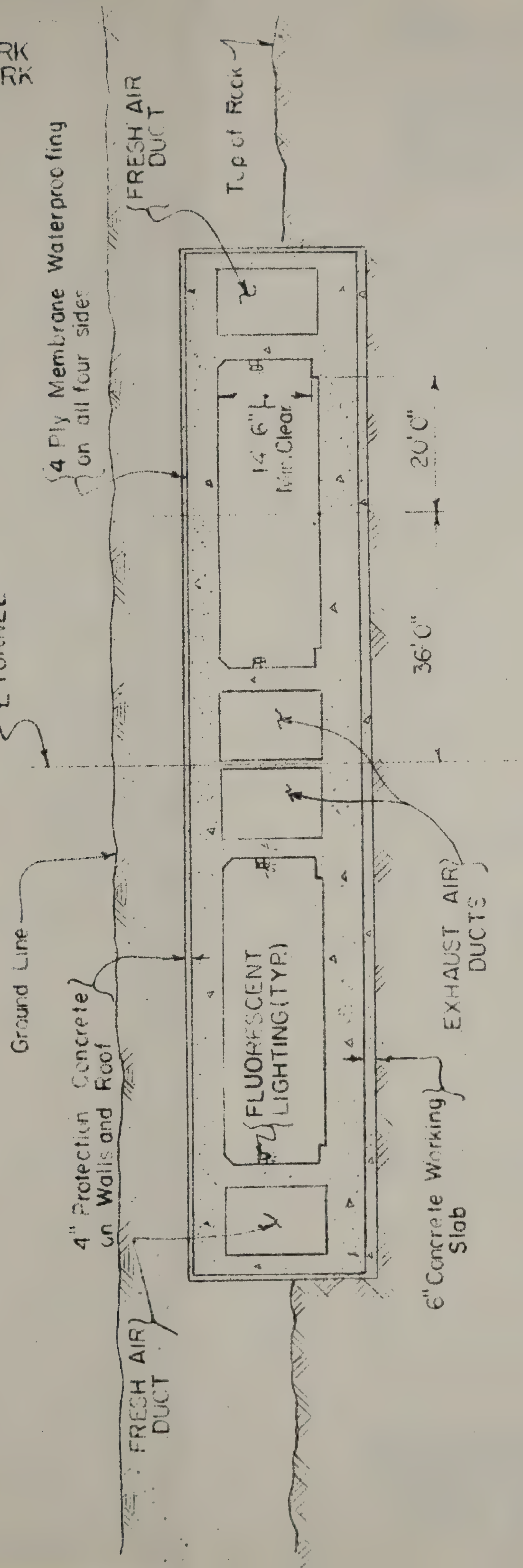
Heavy leakage of ground water through faulty construction joint in tremie concrete seal. (New River Tunnel, Florida). Attempts to stop water inflow by injecting grout through grout needles in the foreground of photograph proved unsuccessful. Excavation was allowed to flood and repairs were made underwater.

Figure 13

Settlement cracks in building adjacent to cut-and-cover excavation (Mobile River Tunnel, Alabama).

GENESEE VALLEY PARK
ROCHESTER, NEW YORK

PLATE TWO



ALTERNATE-ONE
CUT AND COVER SECTION
PORTAL TO PORTAL

Del: J. Campoli 5/23/73

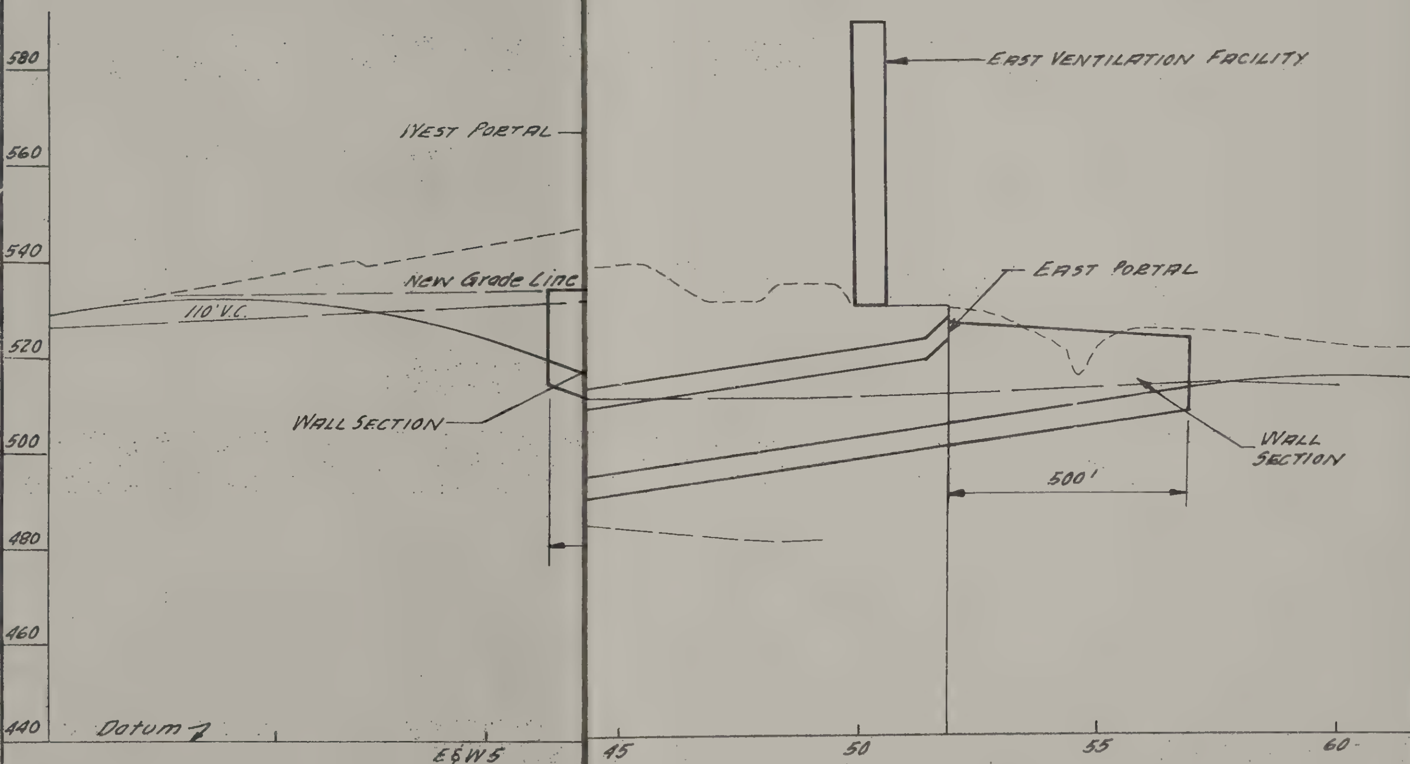
FED. ROAD REG. NO.	STATE	FEDERAL AID PROJECT NO.	SHEET NO.	TOTAL SHEETS
1	N.Y.			

ROCHESTER OUTER LOOP

SCOTTSVILLE RD. TO LEHIGH VALLEY RAILROAD

CUT & COVER TUNNEL (MODIFIED)

PIN 4040.20



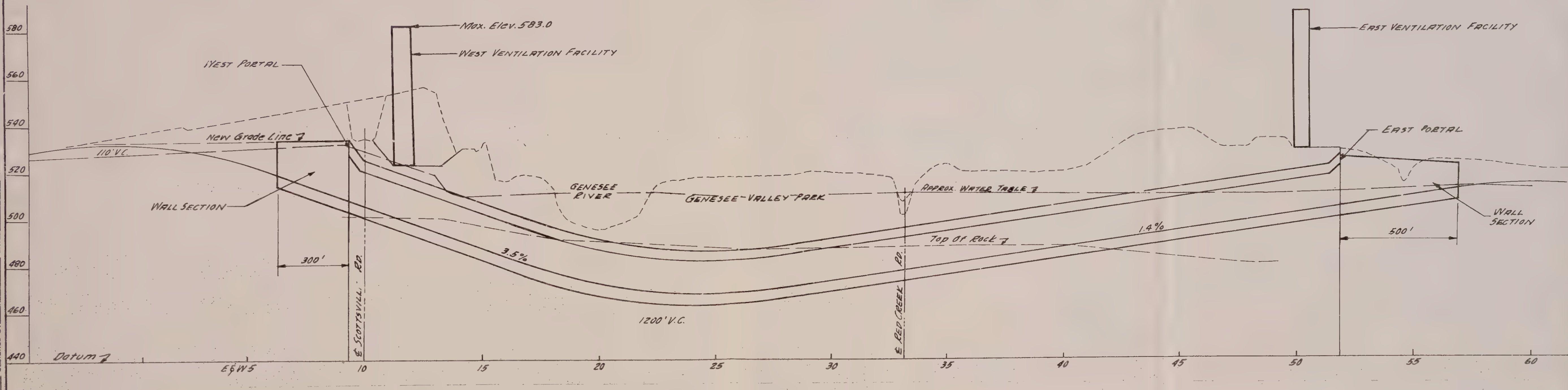
SCALE: 1" = 200' HOR.
1" = 20' VERT.

ALTERNATE ONE
PLATE-THREE
PAGE 20

IN CHARGE OF ___ DESIGNED BY ___ DATED ___ CHECKED BY ___ DATED ___ REVIEWED BY ___ DATED ___

FED. ROAD REG. NO.	STATE	FEDERAL AID PROJECT NO.	SHEET NO.	TOTAL SHEETS
1	N.Y.			

ROCHESTER OUTER LOOP
SCOTTSVILLE RD. TO LEHIGH VALLEY RAILROAD
CUT & COVER TUNNEL (MODIFIED)
PIN 4040.20



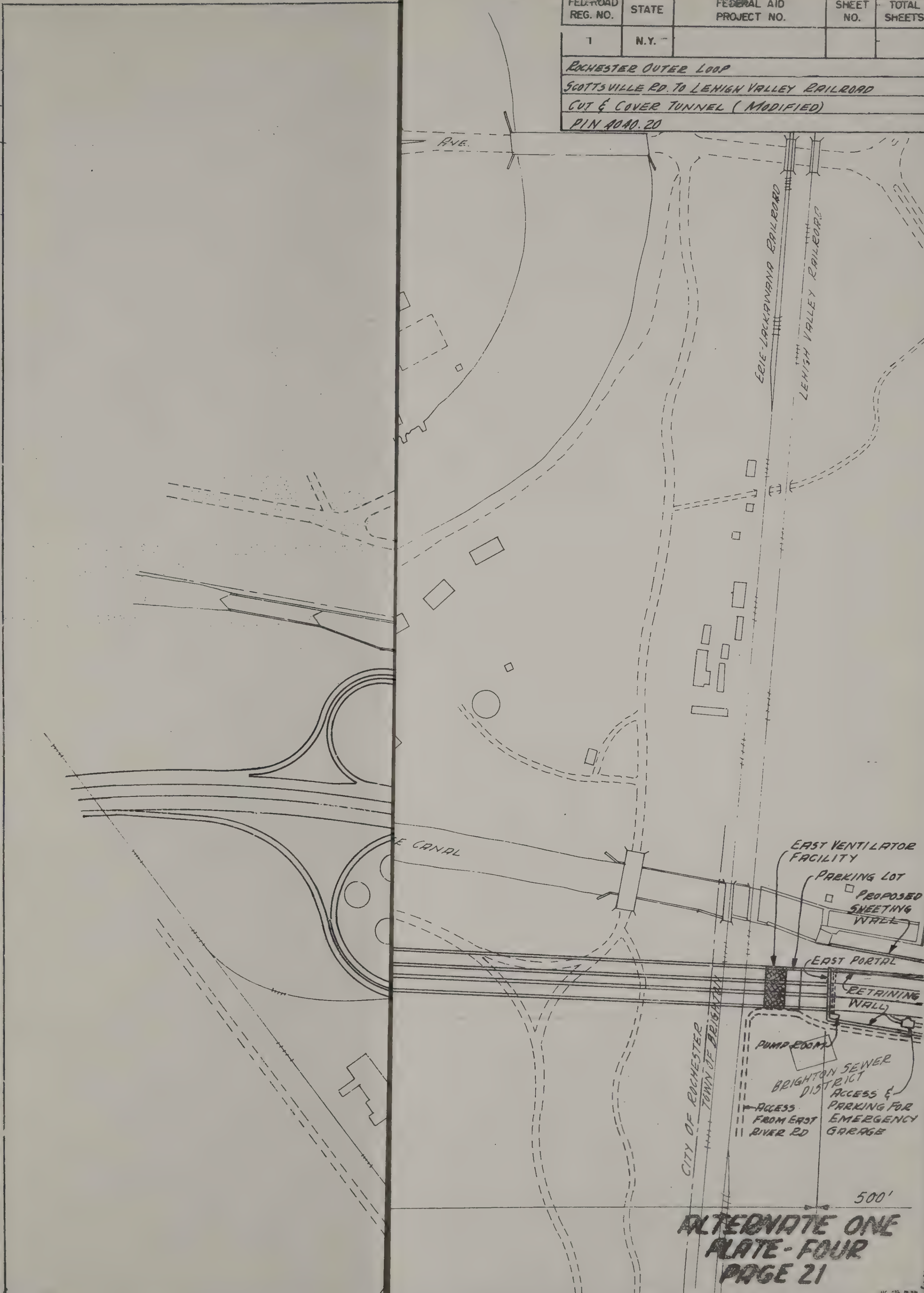
SCALE: 1" = 200' HOR. 1" = 20' VERT.

ALTERNATE ONE
PLATE-THREE
PAGE 20

IN CHARGE OF ____ DESIGNED BY ____ DATED ____ CHECKED BY ____ DATED ____ REVIEWED BY ____ DATED ____

FED. ROAD REG. NO.	STATE	FEDERAL AID PROJECT NO.	SHEET NO.	TOTAL SHEETS
1	N.Y.			

ROCHESTER OUTER LOOP
SCOTTSVILLE RD. TO LEHIGH VALLEY RAILROAD
CUT & COVER TUNNEL (MODIFIED)
PIN 4040.20



ALTERNATE ONE
PLATE - FOUR
PAGE 21

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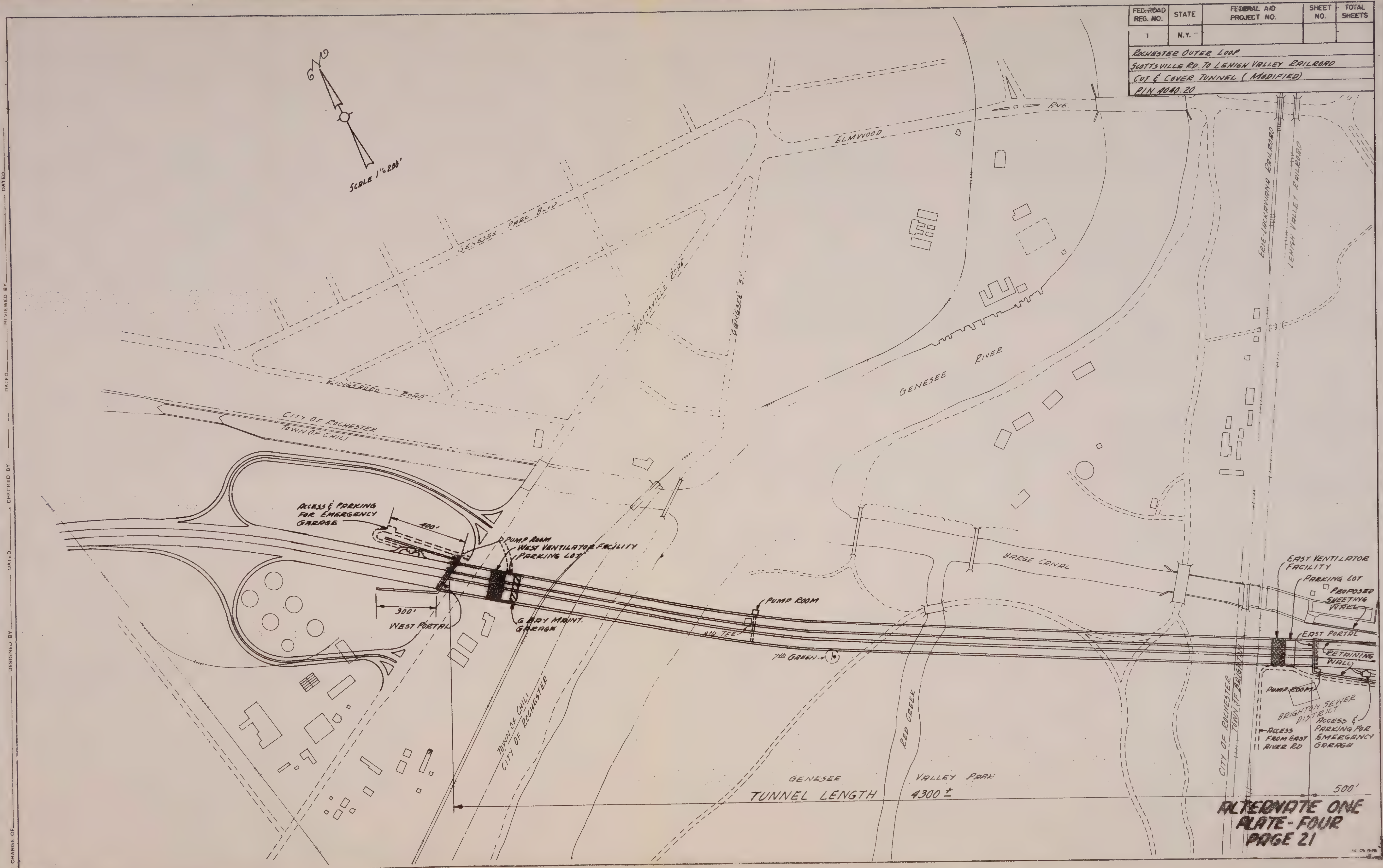
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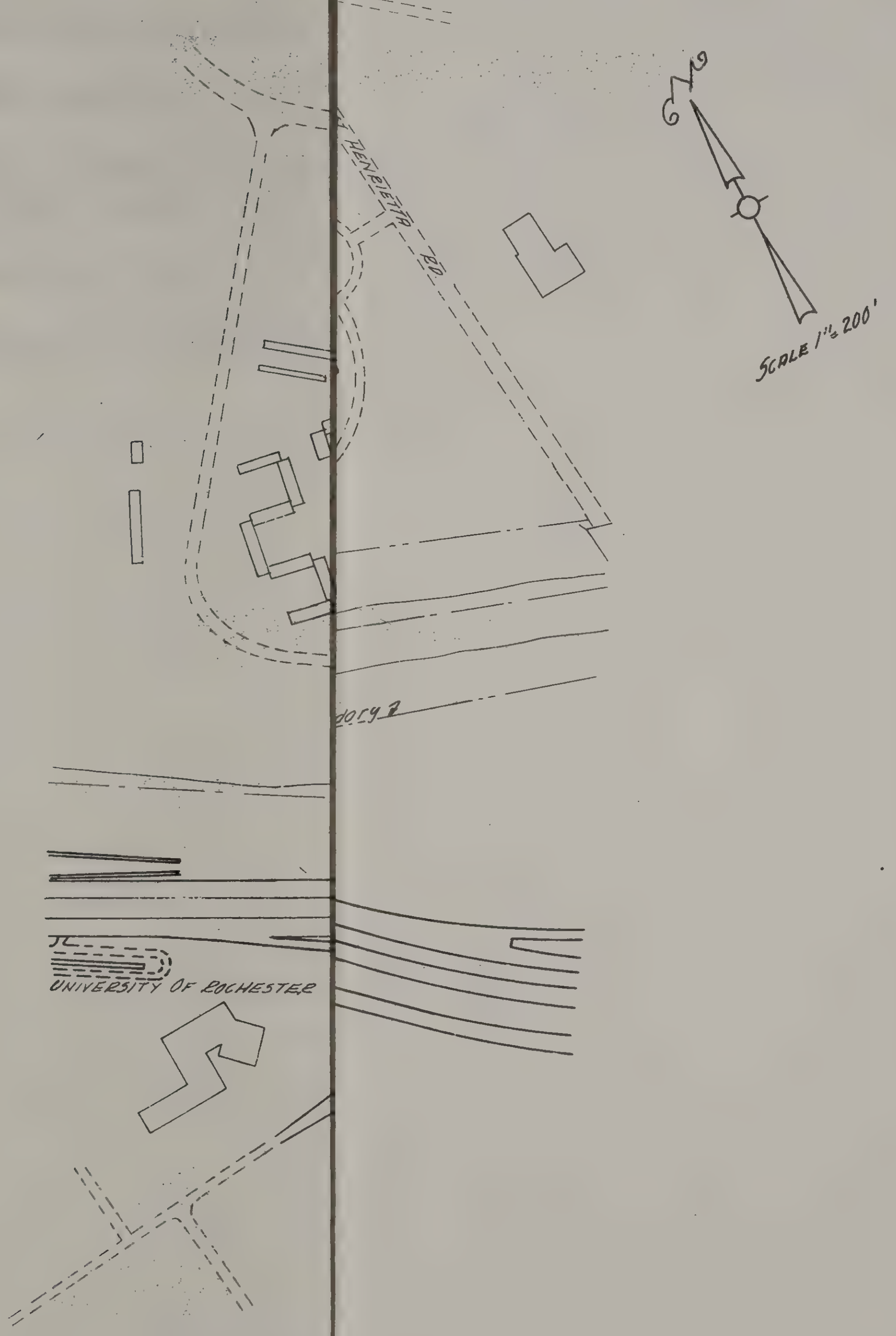
STATE
FEDERAL AID PROJECT NO.
SHEET NO.
TOTAL SHEETS
1
N.Y.
ROCHESTER OUTER LOOP
SCOTTSVILLE RD. TO LEHIGH VALLEY RAILROAD
CUT & COVER TUNNEL (MODIFIED)
PIN 4040.20
SCALE 1"=200'
GENESEE PARK BLVD
ELMWOOD AVE.
SCOTTSVILLE ROAD
GENESEE ST.
KINGSBORO ROAD
CITY OF ROCHESTER
TOWN OF CHILI
GENESEE RIVER
ERIE-LACKAWANNA RAILROAD
LEHIGH VALLEY RAILROAD
ACCESS & PARKING FOR EMERGENCY GARAGE
400'
PUMP ROOM
WEST VENTILATOR FACILITY
PARKING LOT
300'
WEST PORTAL
6 BAY MAINT. GARAGE
BARGE CANAL
PUMP ROOM
8th TEE
7th GREEN
EAST VENTILATOR FACILITY
PARKING LOT
PROPOSED SHEETING WALL
EAST PORTAL
RETAINING WALL
PUMP ROOM
BRIGHTON SEWER DISTRICT
ACCESS FROM EAST RIVER RD
ACCESS & PARKING FOR EMERGENCY GARAGE
TOWN OF CHILI
CITY OF ROCHESTER
RED CREEK
CITY OF ROCHESTER
TOWN OF BRIGHTON
GENESEE VALLEY PARK
TUNNEL LENGTH 4300 ±
500'
ALTERNATE ONE
PLATE - FOUR
PAGE 21

FED. ROAD REG. NO.	STATE	FEDERAL AID PROJECT NO.	SHEET NO.	TOTAL SHEETS
1	N.Y.			

ROCHESTER OUTER LOOP
SCOTTSVILLE RD. TO LEHIGH VALLEY RAILROAD
CUT & COVER TUNNEL (MODIFIED)
PIN 4040.20



ALTERNATE ONE
PLATE-FOUR A
PAGE 21A

IN CHARGE OF ___ DESIGNED BY ___ DATED ___ CHECKED BY ___ DATED ___ REVIEWED BY ___ DATED ___

FED. ROAD REG. NO.	STATE	FEDERAL AID PROJECT NO.	SHEET NO.	TOTAL SHEETS
1	N.Y.			

ROCHESTER OUTER LOOP
SCOTTSVILLE RD. TO LEHIGH VALLEY RAILROAD
CUT & COVER TUNNEL (MODIFIED)
P.I.N. 4040.20

IN CHARGE OF ____ DESIGNED BY ____ DATED ____ CHECKED BY ____ DATED ____ REVIEWED BY ____ DATED ____

ALTERNATE ONE
PLATE-FOUR A
PAGE 21A

Based on the foregoing, Alternate One involves a tunnel installation of the following major dimensions:

Tunnel length, portal to portal	4,300 ft.
Open depressed approach Structures	900 ft.
Total length of installation from grade point to grade point	6,430 ft.

The details of the estimated construction cost of Alternate One are contained in Section H.

F. ALTERNATE TWO

Since cut-and-cover tunnel construction within the limits of the Genesee Valley Park would cause large scale, long term disruption in this sensitive area, a second alternate which would have a less destructive effect on the park grounds was studied. In this alternate the tunnel profile is lowered so that all tunnel construction within the park would be located in the existing underlying rock. The tunnel would be constructed through this rock by mining methods (commonly termed a "driven tunnel").

Although the depth to rock and rock type have been determined by shallow borings, the study of Alternate Two was very severly hampered by the lack of quantitative and qualitative information on the engineering properties of the underlying rock. This lack of subsurface information is particularly serious in the Rochester area because destructive rock movements have been experienced throughout this region when the rock has been disturbed or unloaded by excavations. To obtain the necessary data needed to make a completely realistic design and cost estimate would involve heavy expenditures of time and money which cannot be justified at this stage of the investigations. In the absence of this information on the rock stratum, several assumptions were made in order to complete the study. All of

these assumptions are regarded as optimistic. Therefore, it must be emphasized here that the design and cost estimates depicted in this report should be considered absolute minimum values.

In the event later subsurface explorations reveal that the rock is highly stressed and will exert extraordinary pressures on the tunnel structure, or that the rock will be sufficiently permeable so as to preclude control of water inflows by nominal pumping, the cost of Alternate Two could easily increase as much as 300% and required construction time could double. More precise definition of these upper limits is regarded as outside the scope of this report.

The drill and blast cycle of tunnel excavation continues to dominate as the construction procedure for large sized underground openings such as highway tunnels. Generally, the cycle has the following sequence:

1 - Drilling (holes are drilled in a predetermined pattern in the rock face to be excavated).

2 - Shooting (holes are loaded with explosives and detonated).

3 - Ventilating (fumes from blast are removed from tunnel).

4 - Mucking (broken rock is loaded into trucks and hauled out of tunnel).

5 - Erecting supports (structural steel ribs are placed in tunnel to maintain opening until final concrete lining is placed).

If the rock is highly competent (hard and massive) a length of the full tunnel cross-section could be excavated with each drill and blast cycle. This procedure is known as the "full-face method." However, rock of such high quality is extremely rare at the shallow depths being studied here. It is reasonable to assume that in an excavation as large as that required at this site, the rock will not remain self-supporting long enough for the mucking operations to be completed and supports installed. Therefore, something less than the full tunnel cross-section must be excavated so that the rock will not remain unsupported beyond its "stand-up time." It has been assumed that the material here will be of sufficient quality to permit driving of the tunnel by the "top heading and bench" method (See Fig. 14).

In this procedure, the upper portion of the tunnel is excavated (top heading) from portal to portal as one operation. The lower portion of the cross-section, or bench, is then removed as a separate second operation. This method of construction is illustrated in Figs. 15 through 19.

The cross-section for the driven tunnel portion of Alternate Two is shown on Plate Five. A semi-circular roof arch with

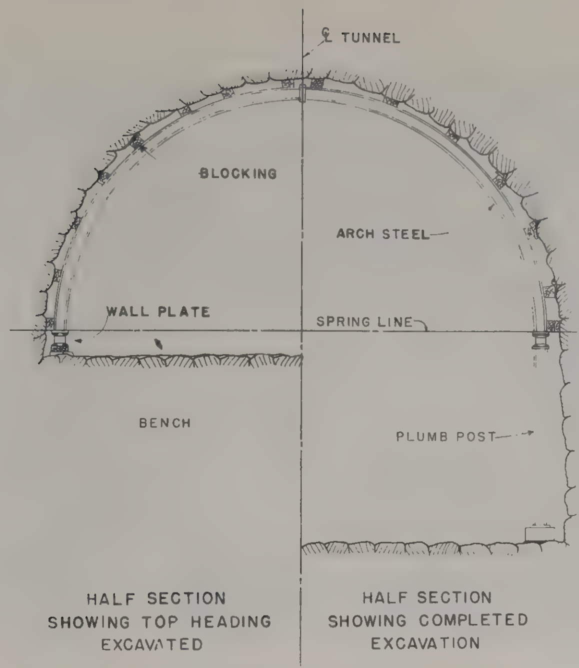


Figure 14

Diagram of "top heading and bench" method of tunnel excavation.

Figure 15

Rail-mounted top heading drill jumbo. (Straight Creek Tunnel, Colorado). This piece of equipment contains platforms on which drills are positioned for drilling at the working face of the tunnel. Explosive truck is shown passing through jumbo on its way into the tunnel to load holes. Arch steel is being placed on jumbo for erection when mucking has been completed. Tunnel section consists of two 13 foot wide traffic lanes.

Figure 16

Erecting arch steel from drill jumbo in top heading. (Straight Creek Tunnel, Colorado).

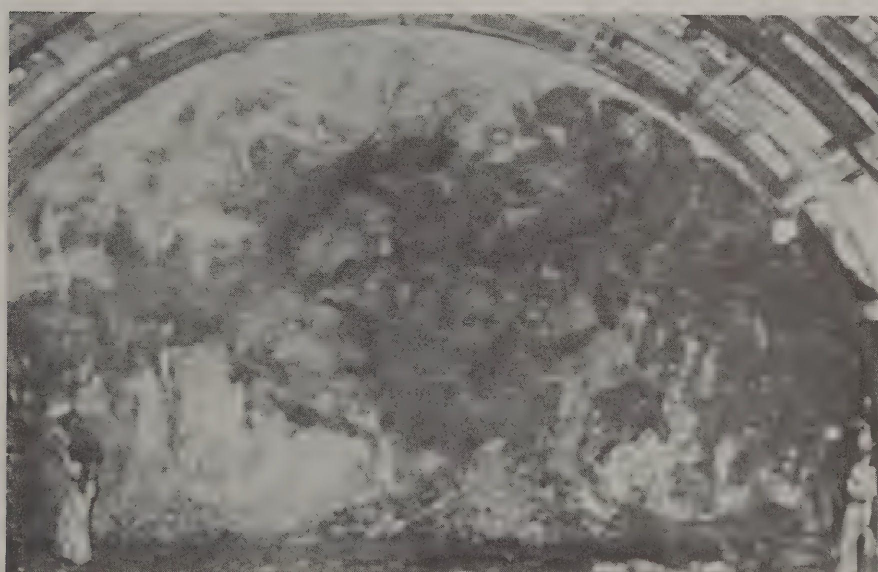


Figure 17

View of rock face in top heading. One drill and blast cycle has been completed and face is being inspected prior to beginning the drilling operations for another cycle. (Straight Creek Tunnel, Colorado)

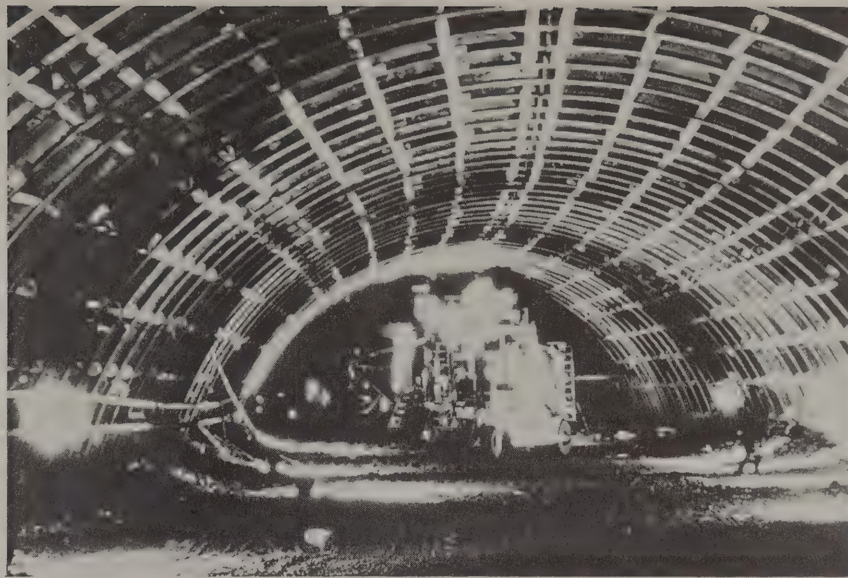


Figure 18

A completed section of top heading. (Vista Ridge Tunnel, Oregon). Tunnel section carries three traffic lanes in a 41 foot wide roadway.

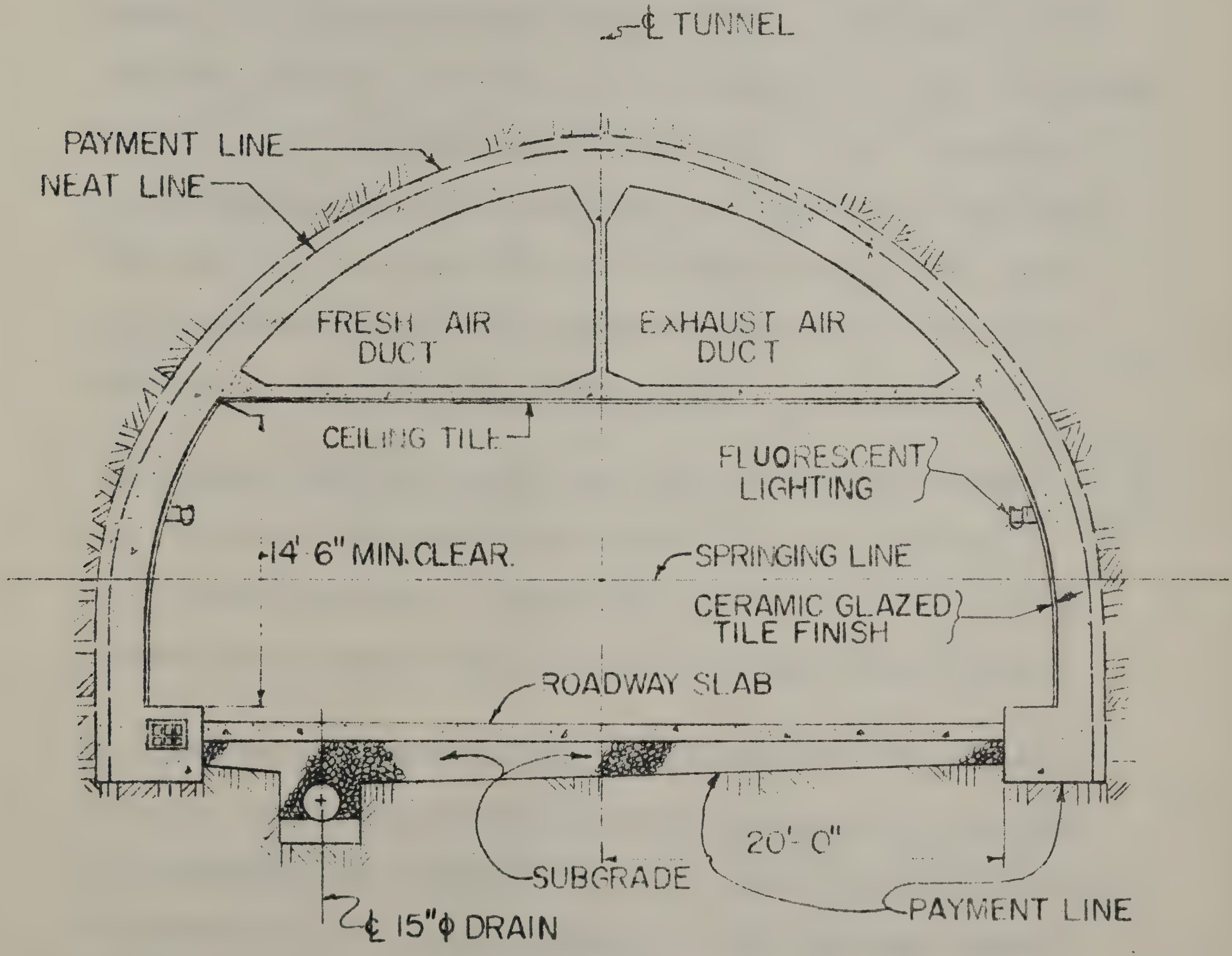
Figure 19

View of completed tunnel excavation. In the foreground forms are being moved into position for placing of the permanent reinforced concrete tunnel lining. (Big Walker Mountain Tunnel, Virginia). Tunnel accommodates two 13 foot traffic lanes.

GENESEE VALLEY PARK
ROCHESTER, NEW YORK

PLATE [illegible]

ROCHESTER OUTER LOOP
SCOTTSVILLE ROAD TO LEHIGH RAILROAD
MONROE COUNTY P.I.N. 4[illegible] 4[illegible].20



ALTERNATE TWO
TYPICAL CROSS SECTION
TUNNEL IN ROCK

straight sidewalls is used to take advantage of the arching action of the tunnel structure and the surrounding rock. It is also expected that this cross-section can be blasted with a minimum amount of overbreak.

Vertical alignment of this alternate is controlled by the height of rock needed above the tunnel arch to permit driving the tunnel (See Fig. 20). A height of ten feet above the tunnel crown at the boundary lines of Genesee Park was selected for study purposes with the full realization that such a dimension is very close to an absolute minimum figure. Rock cores taken in anticipation of the construction of a viaduct indicate that the upper ten or so feet of rock is badly broken. This amount of rock cover is one of the optimistic assumptions previously referred to and yields the profile shown on Plate Six.

The distance between tunnel bores (pillar width) introduces new horizontal curvature in the tunnel alignment as shown on Plate Seven and Seven A. Here again good rock conditions are assumed and a pillar width of 50 feet is used (Plate Eight).

As discussed in Section D, soft ground tunneling is considered to be too costly and hazardous at this location to be included as a practical and reasonable scheme. Instead, the driven tunnel is connected to the approach ramps by a cut-and-cover tunnel

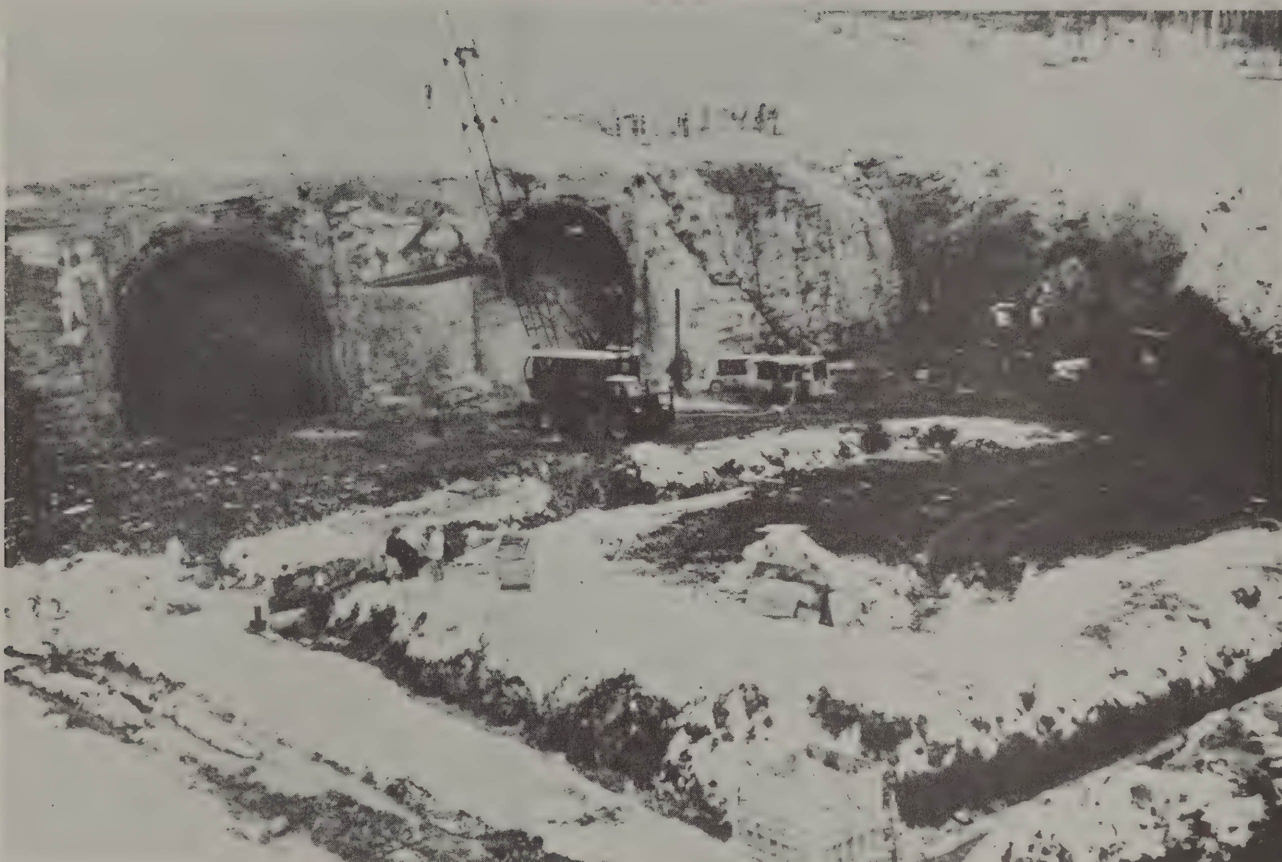
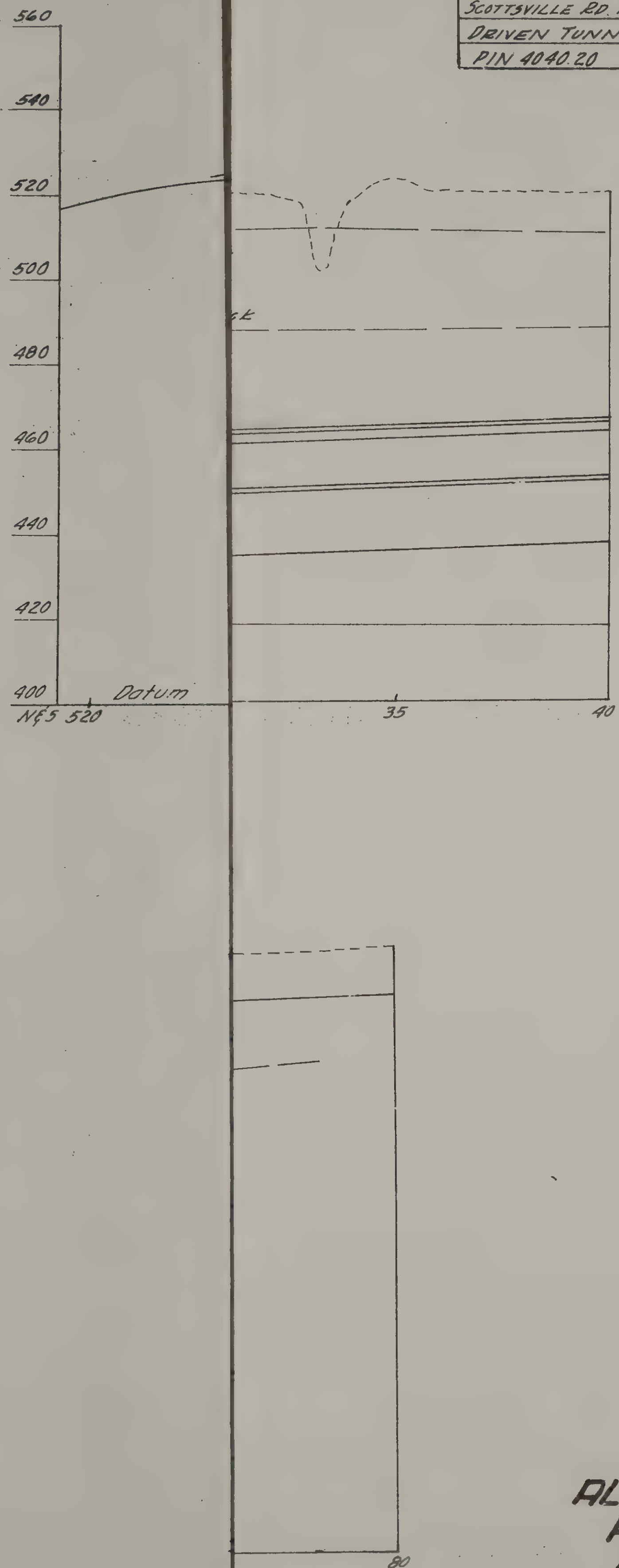


Figure 20

Beginning of tunneling operations after excavation has exposed rock face. Contractor's plant has not yet been constructed for full scale tunnel driving operations. (Big Walker Mountain Tunnel, Virginia).

FED. ROAD REG. NO.	STATE	FEDERAL AID PROJECT NO.	SHEET NO.	TOTAL SHEETS
1	N.Y.			

ROCHESTER OUTER LOOP
SCOTTSVILLE RD. TO LEHIGH VALLEY RAILROAD
DRIVEN TUNNEL
PIN 4040.20

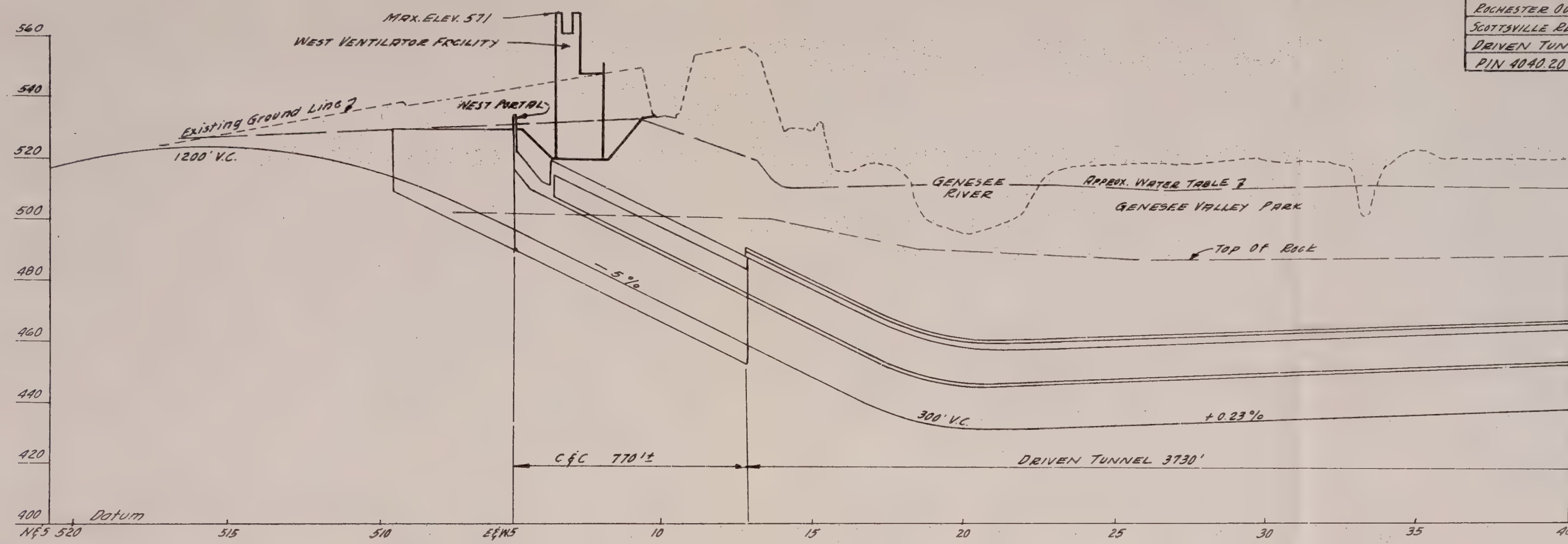


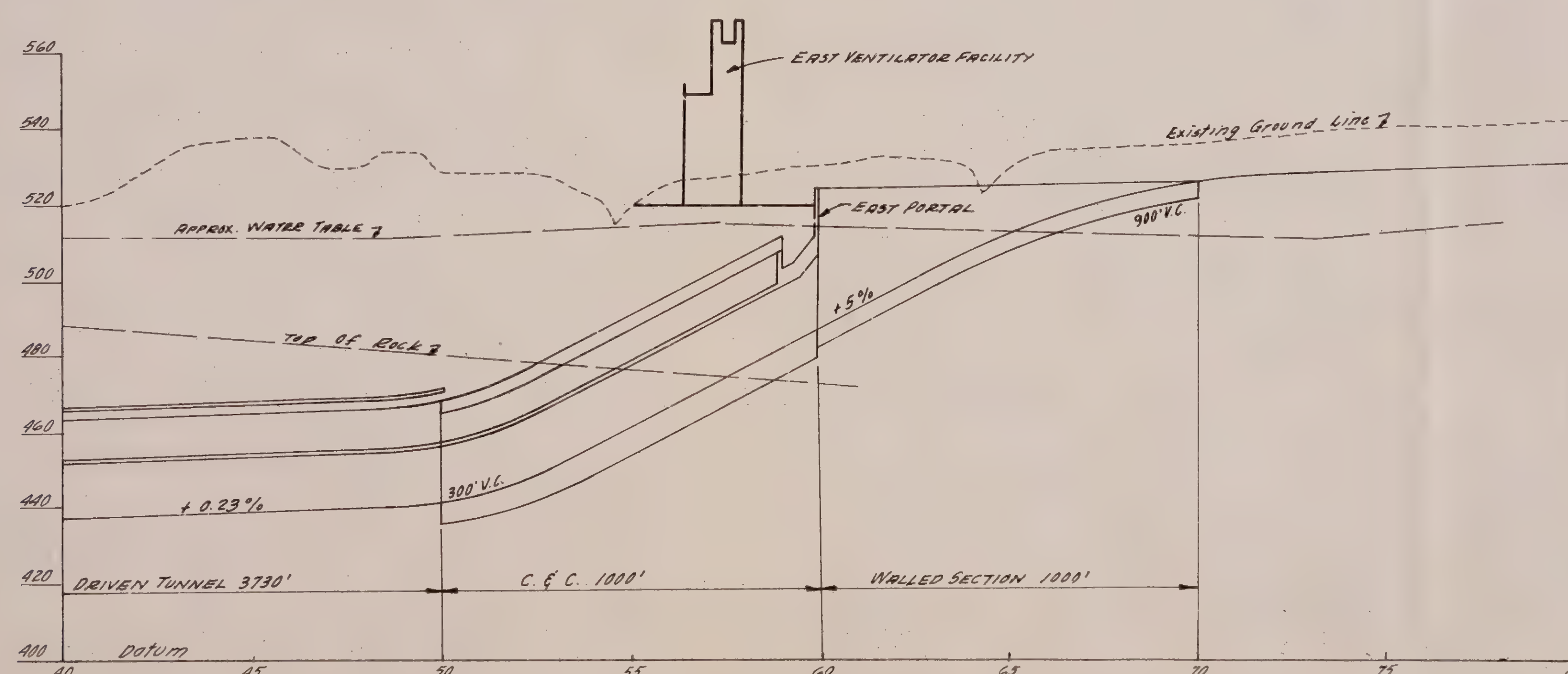
ALTERNATE TWO
PLATE-SIX
PAGE 32

IN CHARGE OF ____ DESIGNED BY ____ DATED ____ CHECKED BY ____ DATED ____ REVIEWED BY ____ DATED ____

FED. ROAD REG. NO.	STATE	FEDERAL AID PROJECT NO.	SHEET NO.	TOTAL SHEETS
1	N.Y.			

ROCHESTER OUTER LOOP
SCOTTSVILLE RD. TO LEHIGH VALLEY RAILROAD
DRIVEN TUNNEL
PIN 4040.20





SCALE: 1" = 200' HOR.
1" = 20' VERT.

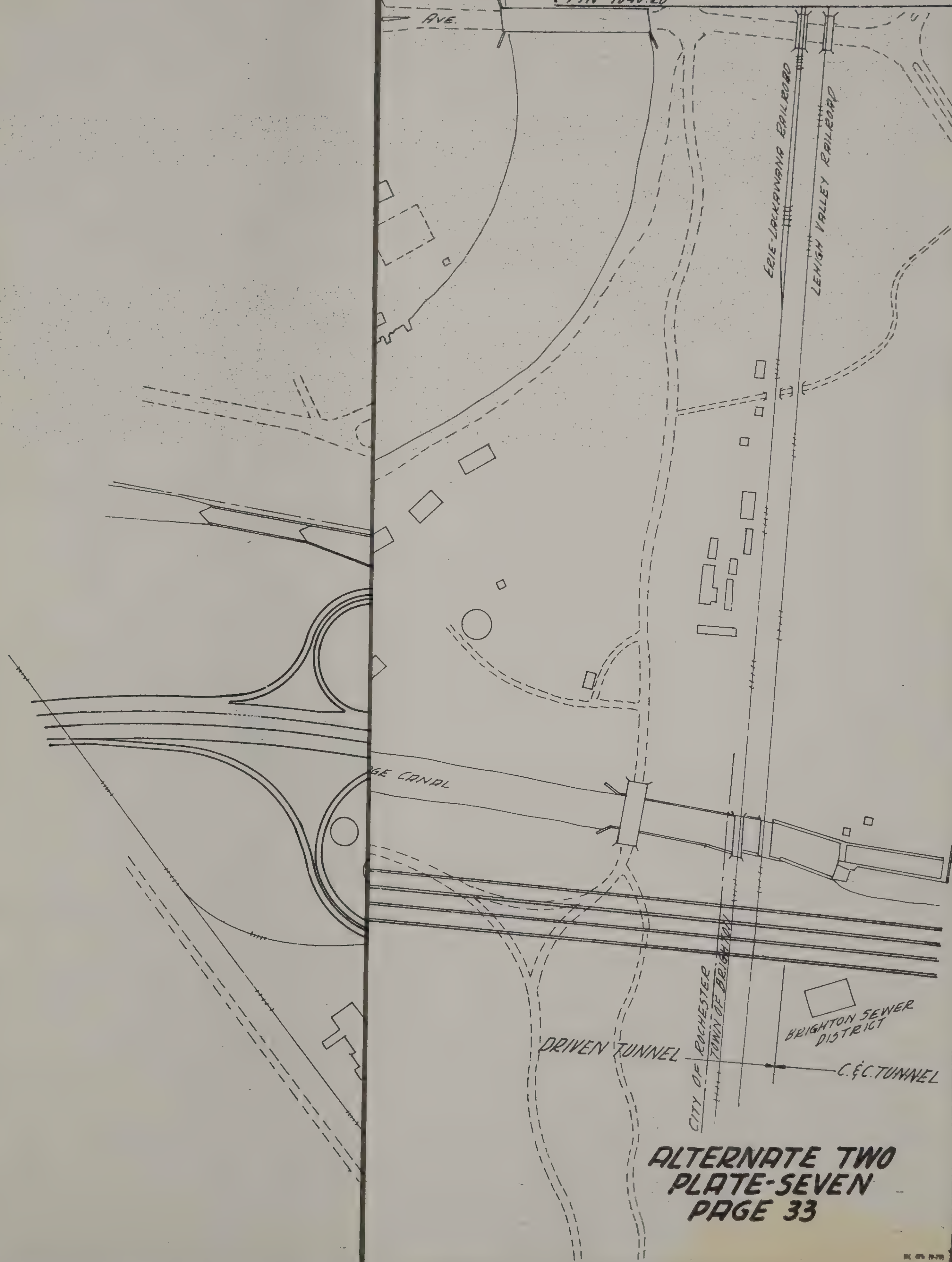
ALTERNATE TWO
PLATE - SIX
PAGE 32

IN CHARGE OF ___ DESIGNED BY ___ DATED ___ CHECKED BY ___ DATED ___ REVIEWED BY ___ DATED ___

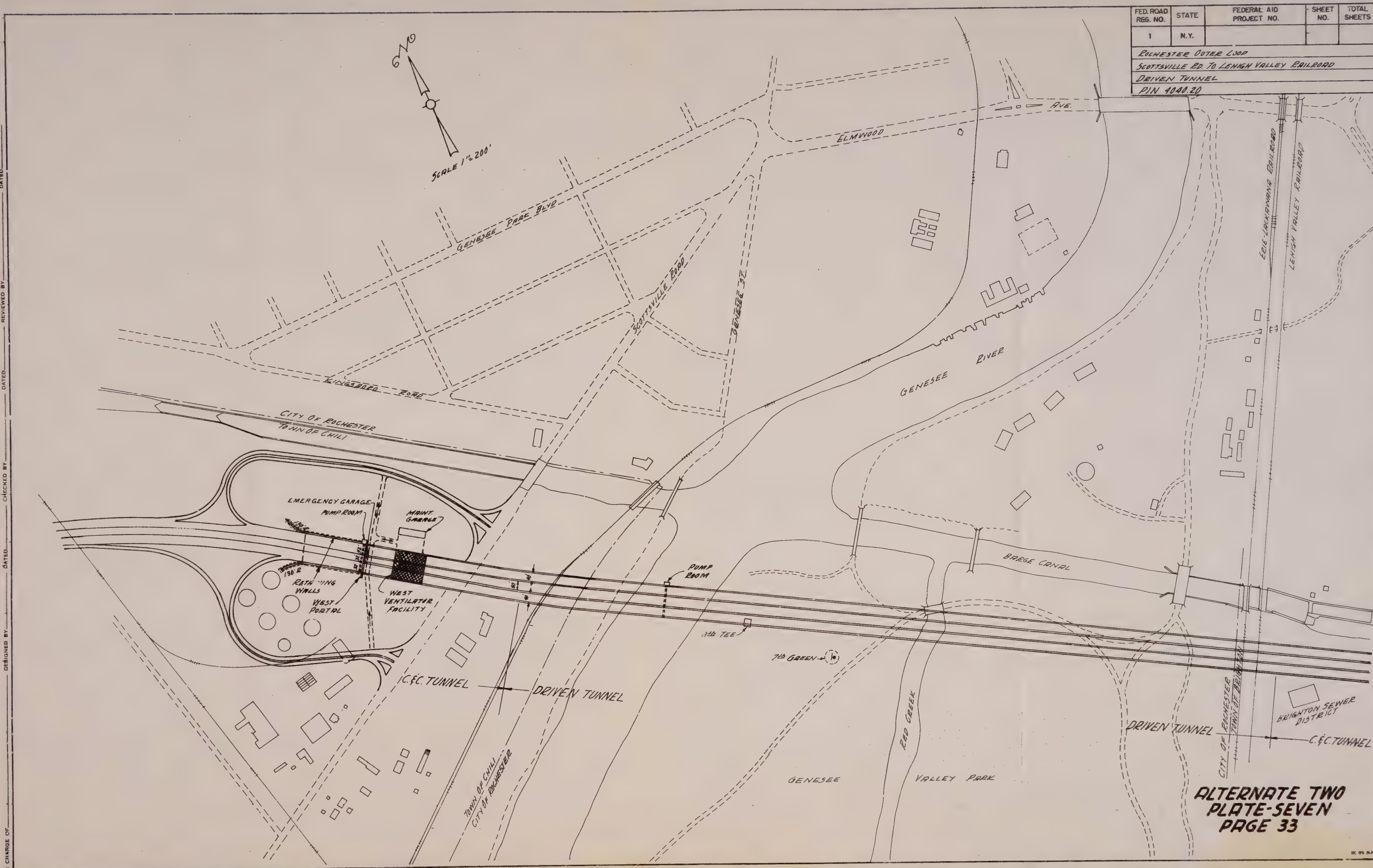
FED. ROAD REG. NO.	STATE	FEDERAL AID PROJECT NO.	SHEET NO.	TOTAL SHEETS
1	N.Y.			

ROCHESTER OUTER LOOP
SCOTTSVILLE RD. TO LEHIGH VALLEY RAILROAD
DRIVEN TUNNEL
PIN 4040.20

IN CHARGE OF ____ DESIGNED BY ____ DATED ____ CHECKED BY ____ DATED ____ REVIEWED BY ____ DATED ____



ALTERNATE TWO
PLATE-SEVEN
PAGE 33


FED. ROAD REG. NO.
STATE
FEDERAL AID PROJECT NO.
SHEET NO.
TOTAL SHEETS
1
N.Y.
ROCHESTER OUTER LOOP
SCOTTSVILLE RD. TO LEHIGH VALLEY RAILROAD
DRIVEN TUNNEL
PIN 4040.20
SCALE 1" = 200'
GENESEE PARK BLVD
ELMWOOD
AVE.
SCOTTSVILLE ROAD
GENESEE ST
KINGSBORO ROAD
CITY OF ROCHESTER
TOWN OF CHILI
GENESEE RIVER
ERIE LACKAWANNA RAILROAD
LEHIGH VALLEY RAILROAD
EMERGENCY GARAGE
PUMP ROOM
MAINT. GARAGE
130' R
RETAINING WALLS
WEST PORTAL
WEST VENTILATOR FACILITY
PUMP ROOM
BARGE CANAL
7th TEE
7th GREEN
C.&C. TUNNEL
DRIVEN TUNNEL
TOWN OF CHILI
CITY OF ROCHESTER
RED CREEK
GENESEE
VALLEY PARK
DRIVEN TUNNEL
CITY OF ROCHESTER
TOWN OF BRIGHTON
C.&C. TUNNEL
BRIGHTON SEWER DISTRICT
IN CHARGE OF
DESIGNED BY
DATED
CHECKED BY
DATED
REVIEWED BY
DATED
ALTERNATE TWO
PLATE-SEVEN
PAGE 33

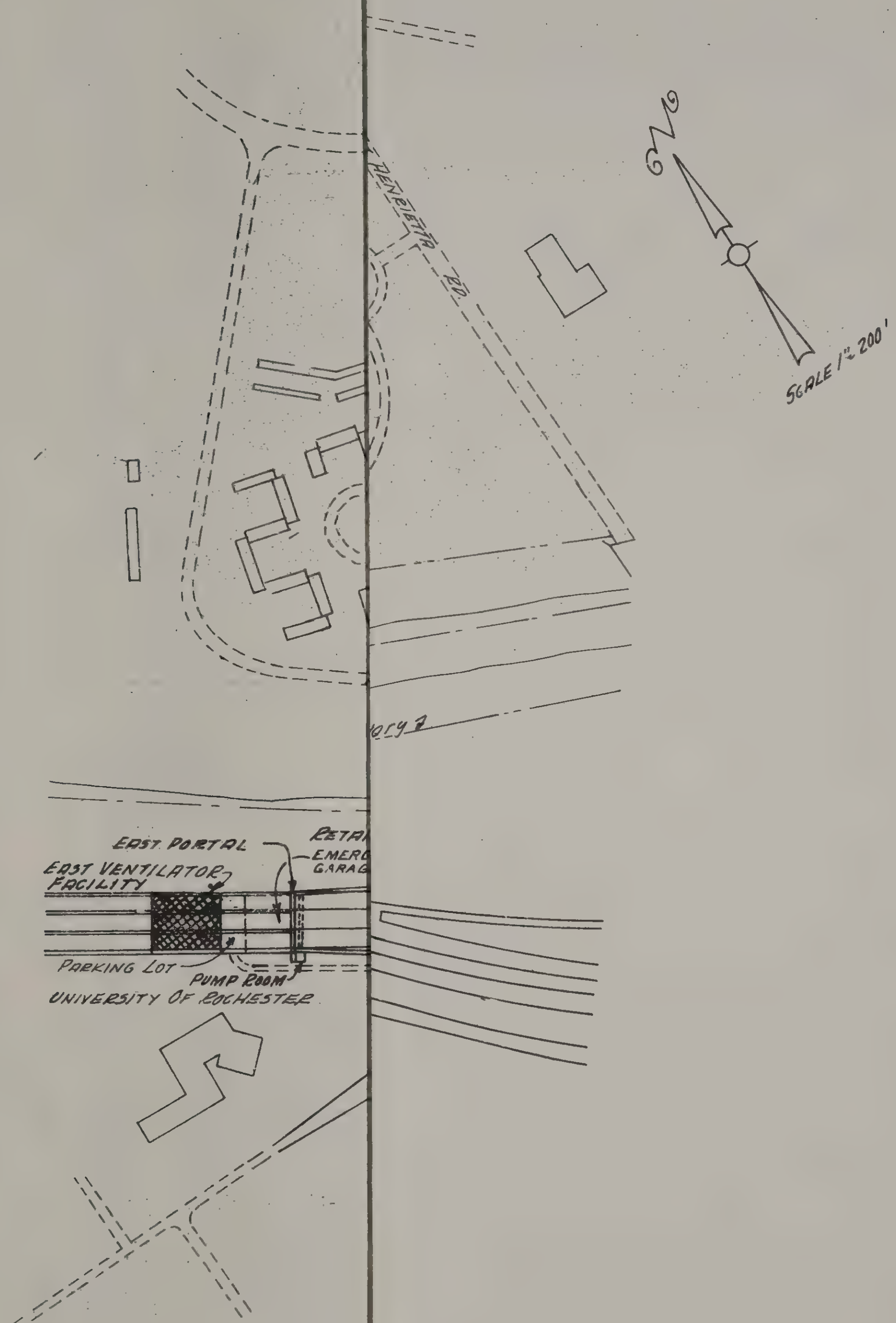
FED. ROAD REG. NO.	STATE	FEDERAL AID PROJECT NO.	SHEET NO.	TOTAL SHEETS
1	N.Y.			

ROCHESTER OUTER LOOP

SCOTTSVILLE RD. TO LEHIGH VALLEY RAILROAD

DRIVEN TUNNEL

PIN 4040.20



ALTERNATE TWO
PLATE-SEVEN A
PAGE 33 A

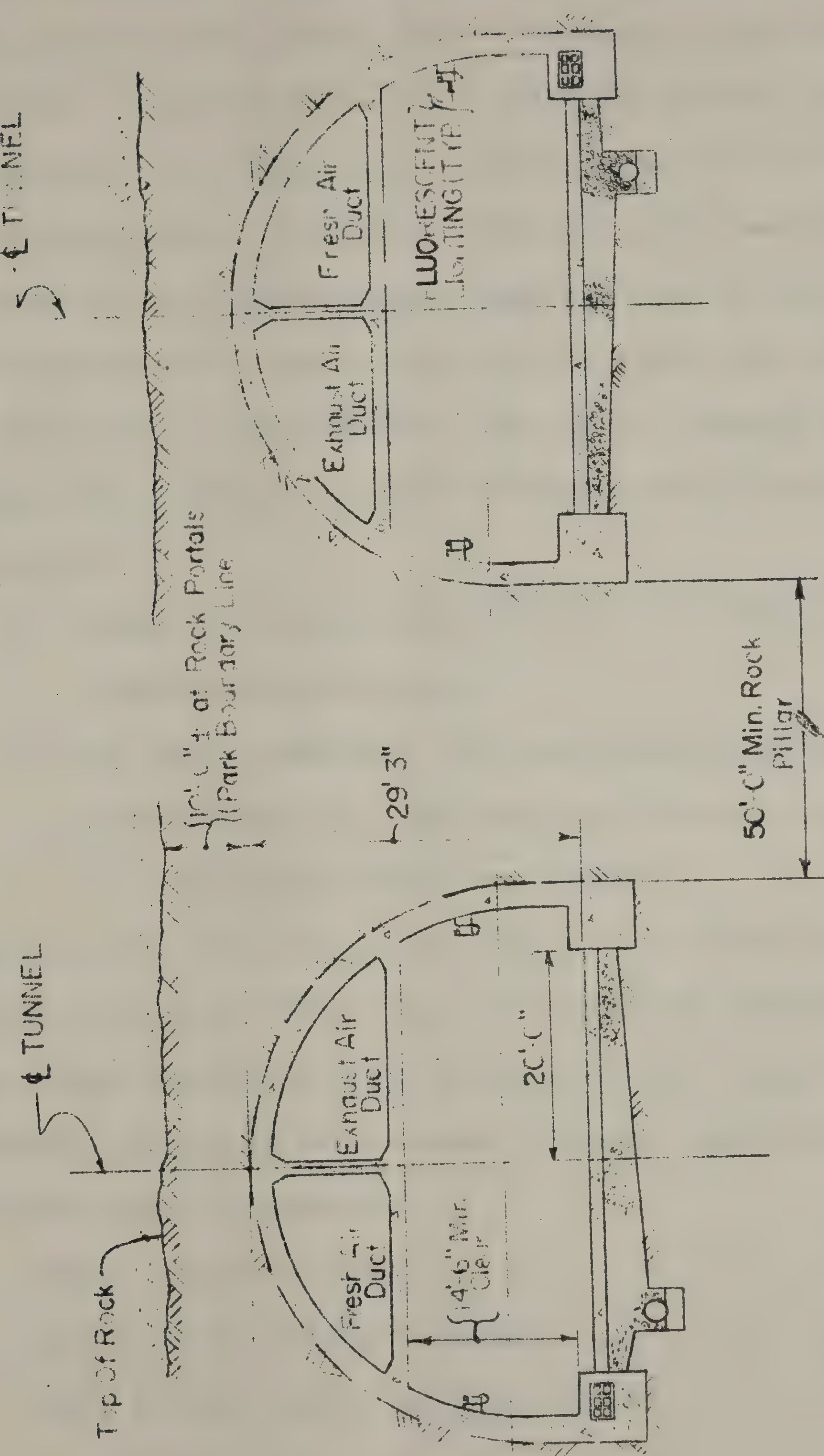
IN CHARGE OF ______ DESIGNED BY ______ DATED ______ CHECKED BY ______ DATED ______ REVIEWED BY ______ DATED ______

FED. ROAD REG. NO.	STATE	FEDERAL AID PROJECT NO.	SHEET NO.	TOTAL SHEETS
1	N.Y.			

ROCHESTER OUTER LOOP
SCOTTSVILLE RD. TO LEHIGH VALLEY RAILROAD
DRIVEN TUNNEL
PIN 4040.20

ALTERNATE TWO
PLATE-SEVEN A
PAGE 33 A

PLATE EIGHT



ALTERNATE TWO-DRIVEN TUNNEL
BENEATH GENESEE VALLEY PARK

Del. J. Compoli 5/16/73

section at each end. The horizontal and vertical alignment of these cut-and-cover connections is dictated by the driven tunnel location, acceptable grades, and fixed end points. These connections will be constructed in manner similar to that described for Alternate One. A slightly different cross-section is used in these cut-and-cover segments than was used in Alternate One. The ventilation air ducts have been relocated from the sides of the structure to the area above the tunnel roadways (See Plate Nine). The following two main advantages are gained by this relocation:

1 - depth of backfill over structure is reduced thereby reducing roof loadings.

2 - air duct transition from cut-and-cover sections to driven tunnel is simplified and pressure losses in ventilation system are reduced.

The transition from the box section with air ducts to the box section without air ducts (both cut-and-cover sections) to the open walled section is shown on Plate Eleven. Based on the foregoing, Alternate Two involves a tunnel installation of the following major dimensions:

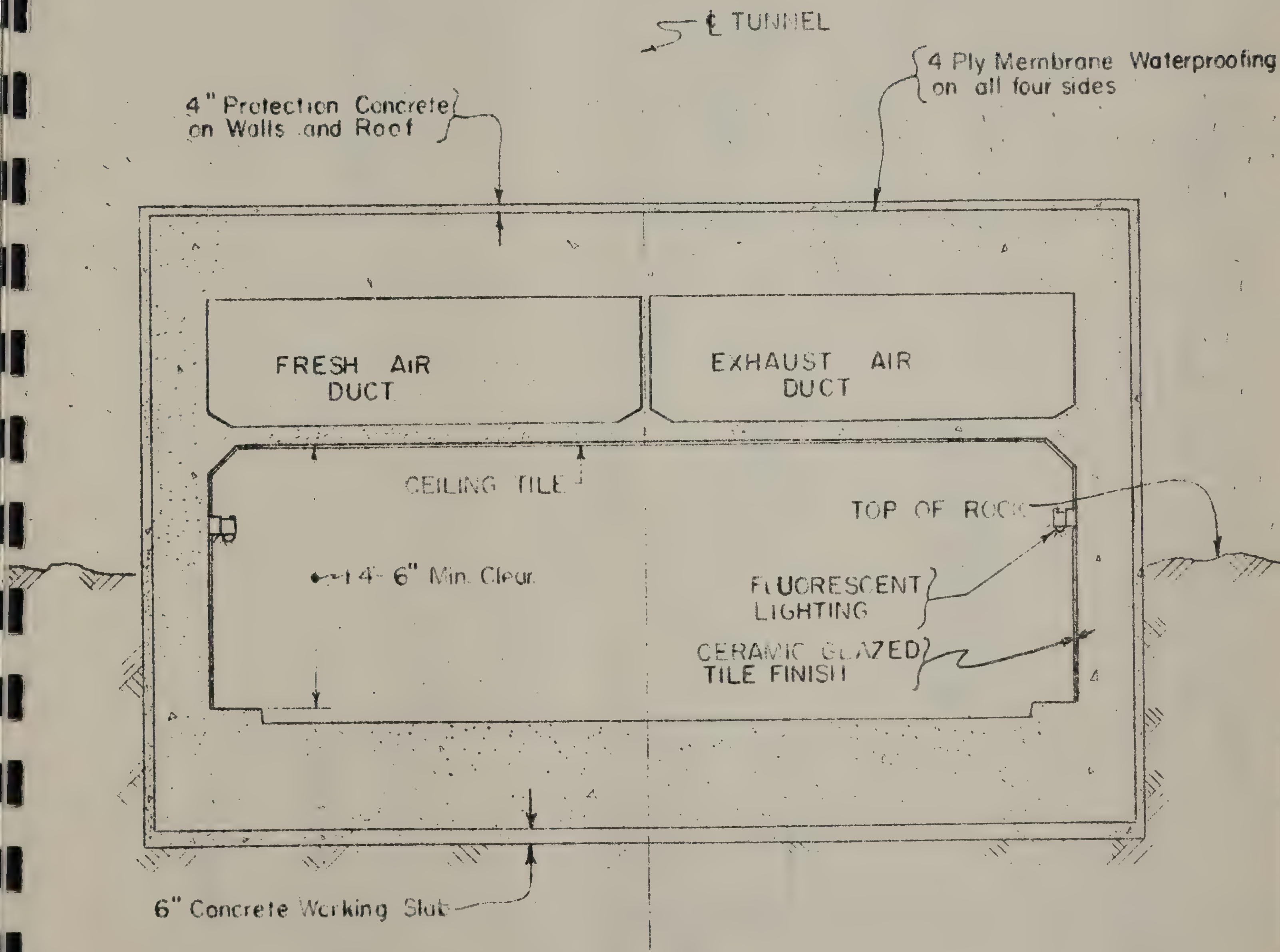
Length of driven tunnel ....3,730 ft.

Length of cut-and-cover tunnel ....1,770 ft.

Total tunnel length, portal to portal ....5,500 ft.

GENESEE VALLEY PARK
ROCHESTER, NEW YORK

PLATE NINE

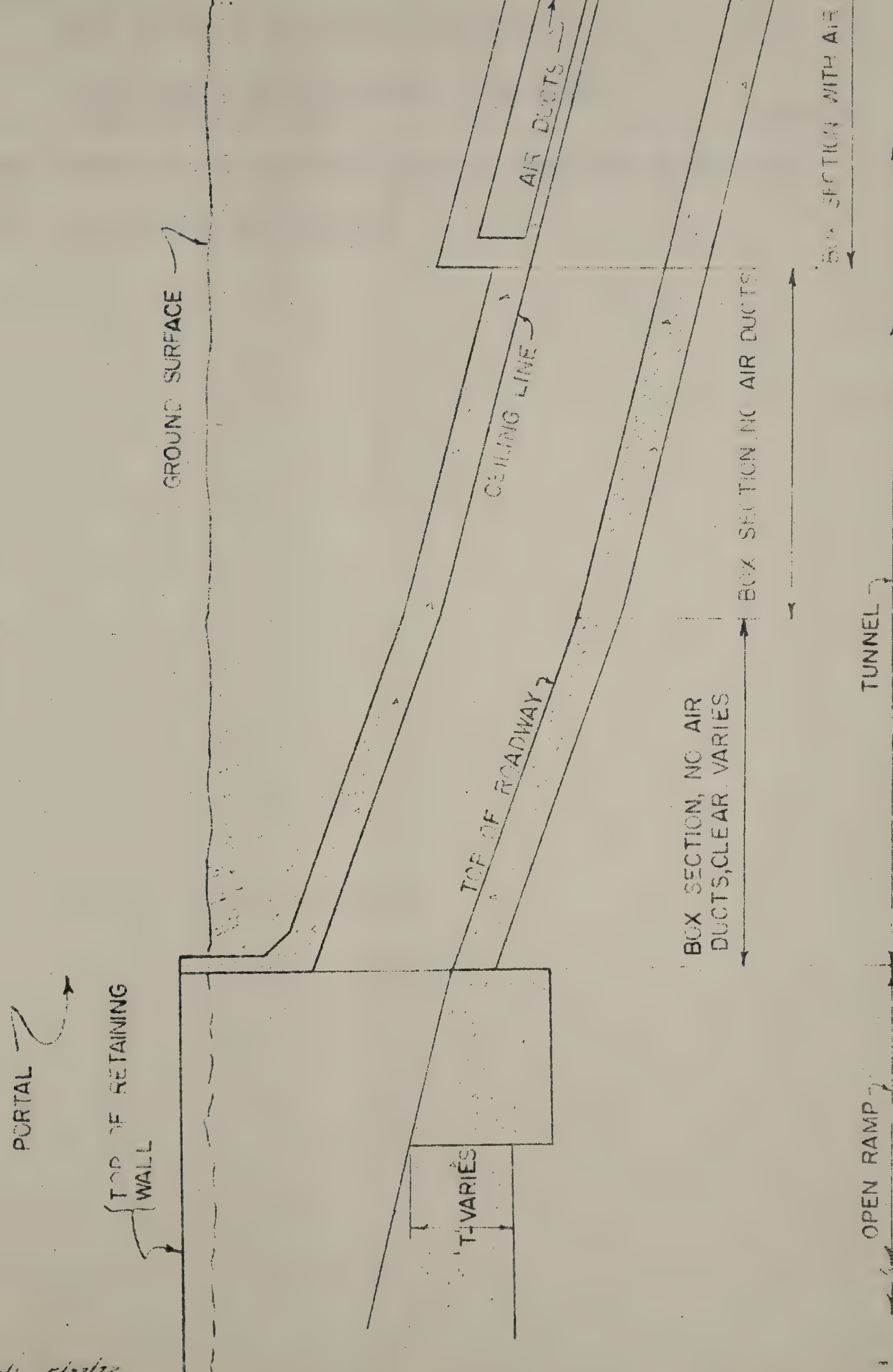


ALTERNATE TWO-DRIVEN TUNNEL
TYPICAL TUNNEL CROSS-SECTION OF
CUT AND COVER SECTIONS

Del. J. Campoli 5/16/73

GENESEE VALLEY PARK
ROCHESTER, NEW YORK

PLATE TEN



ALTERNATE TWO-DRIVEN TUNNEL
DIAGRAM OF LAYOUT AT TUNNEL PORTAL

Det. J. Campoli 5/22/73

Open depressed approach structure .... 1,400 ft.

Total length of installation from grade point to grade point .... 8,050 ft.

The details of the estimated construction cost of Alternate Two is contained in Section H.

G. DESCRIPTION OF DESIGN FEATURES

Open Depressed Approach Structures

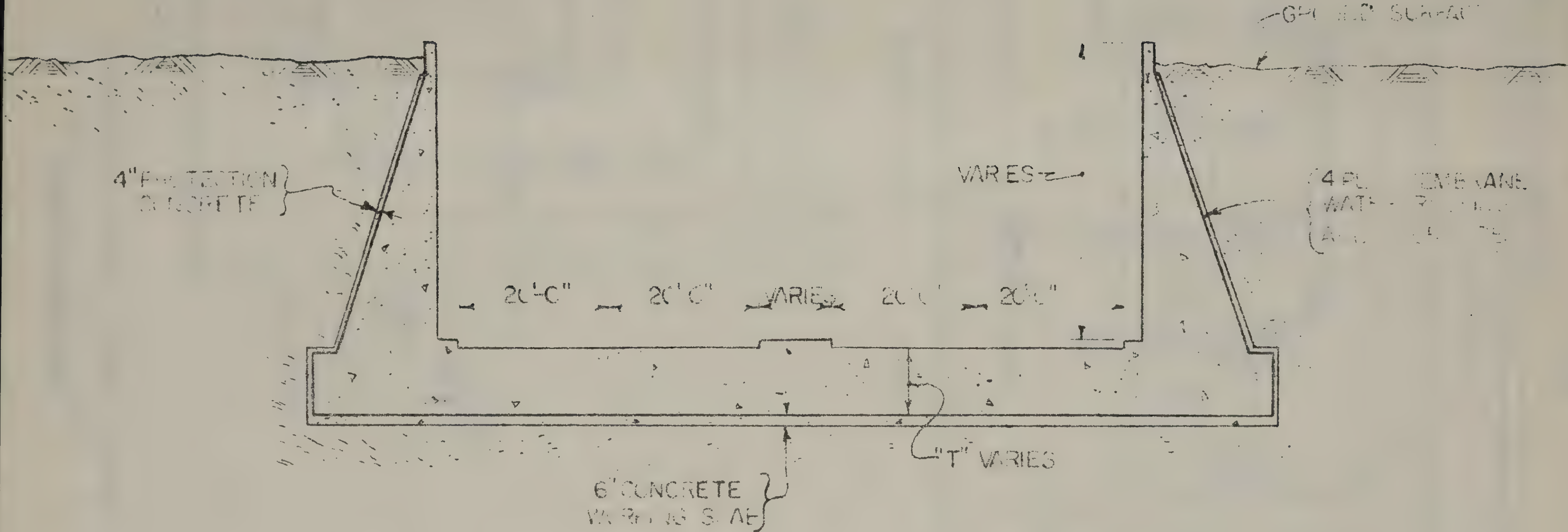
The roadways will be carried from the tunnel portals to grade point in open depressed approaches. These approaches will be "U" shaped reinforced concrete retaining wall structures of sufficient weight to counteract the hydrostatic uplift caused by flood conditions (See Plate Eleven). These structures will be encased in a waterproof envelope of four ply membrane waterproofing. Transverse expansion joints at regular intervals are provided to control cracking due to temperature changes.

It is very desirable to provide the portals and the faces of the retaining walls with an architectural treatment which will reduce the ambient brightness level in the tunnel approaches. This treatment will reduce lighting contrasts and prevent the tunnels from appearing as "black holes." Since many such treatments, within a wide range of costs, could be used, the estimate does not include this item as a significant expense.

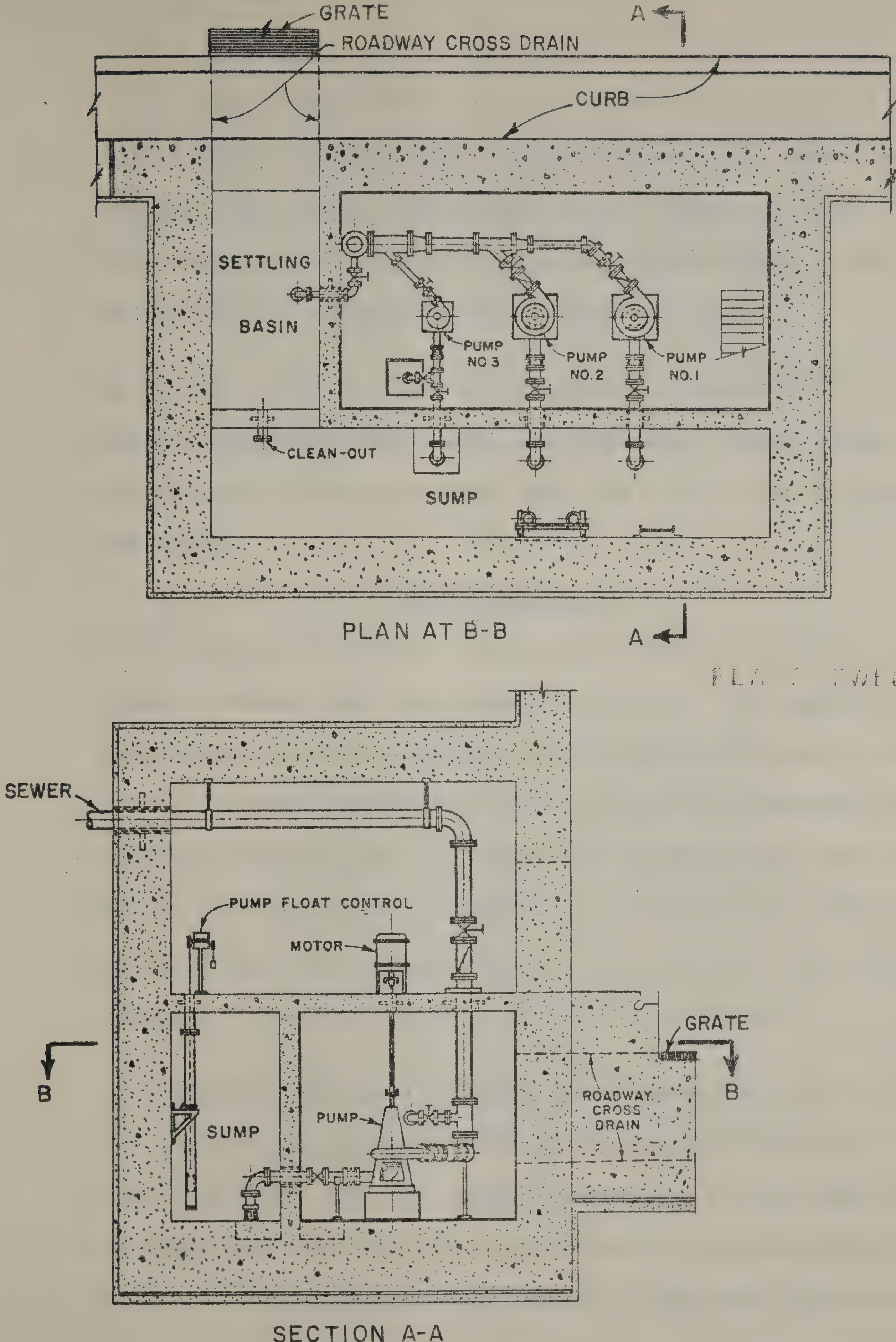
Drainage

All rainwater falling on the open approaches will be drained to the curb lines which will convey the water to the cross drains at each portal. The cross drains carry the drainage to a sump in the underground pump rooms located at each portal (See Plate Twelve). Automatically controlled, electrically powered pumps will discharge the drainage water into existing storm water systems

PLATE ELEVEN



TYPICAL RETAINING WALL SECTION
ALTERNATES ONE AND TWO



TYPICAL PORTAL PUMP ROOM

SCALE 4 0 4 8 FEET

or into the Genesee River. At the low point in the tunnel profile another cross drain is provided to collect tunnel washing water and any seepage which might occur. Automatic pumps at this location will discharge the water through pipes in the tunnel walls to either or both portal pump rooms.

The driven tunnel in Alternate Two will be provided with a drainage system behind the tunnel walls and below the roadway. This system will intercept subsurface water and carry it to the low point pump room.

Tunnel Ventilation

It is necessary to provide mechanical ventilation for the entire length of tunnel for both alternate studies. The capacity of the ventilation system is based on introducing a sufficient volume of fresh air into the roadway areas to provide a safe and comfortable atmosphere and to prevent any smoke or haze which might have an adverse effect on visibility. To insure the safety of the traveling public, especially in the event of a fire in the tunnel, a "transverse" system of ventilation is used.

The transverse ventilation system simultaneously supplies fresh air to the tunnel roadways while extracting the vitiated air. Blower fans (See Fig. 21) located in each of the two ventilation buildings draw in fresh air through louvres in the building walls and force it into the fresh air ducts of the tunnel structure.

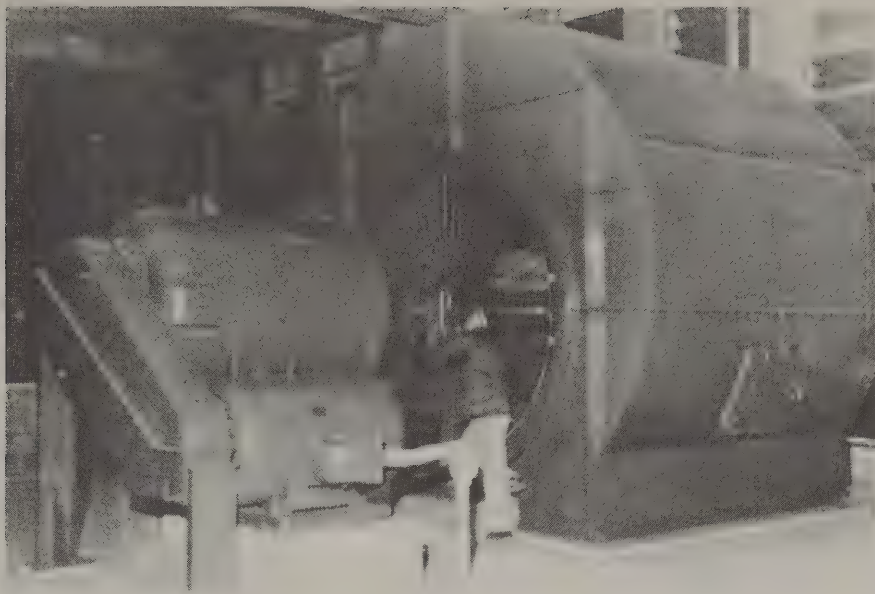
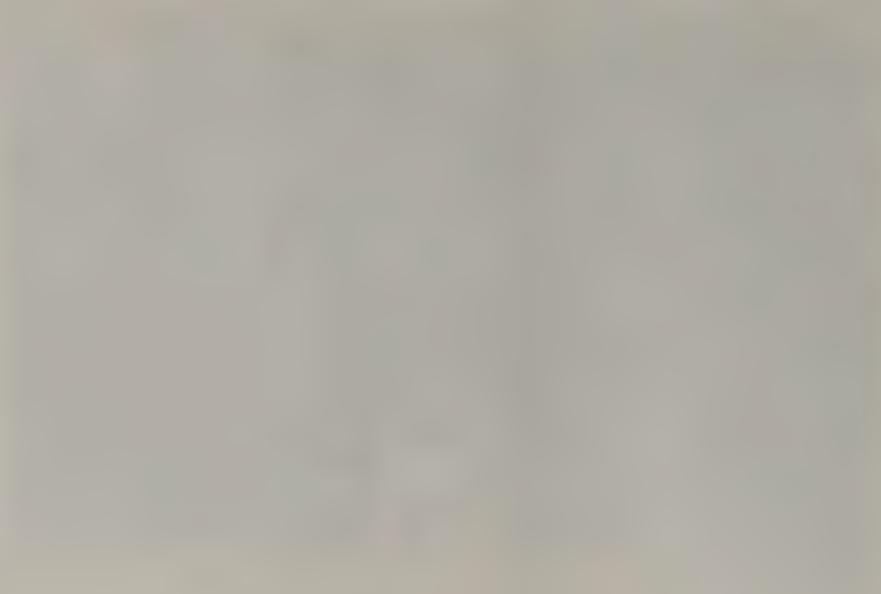


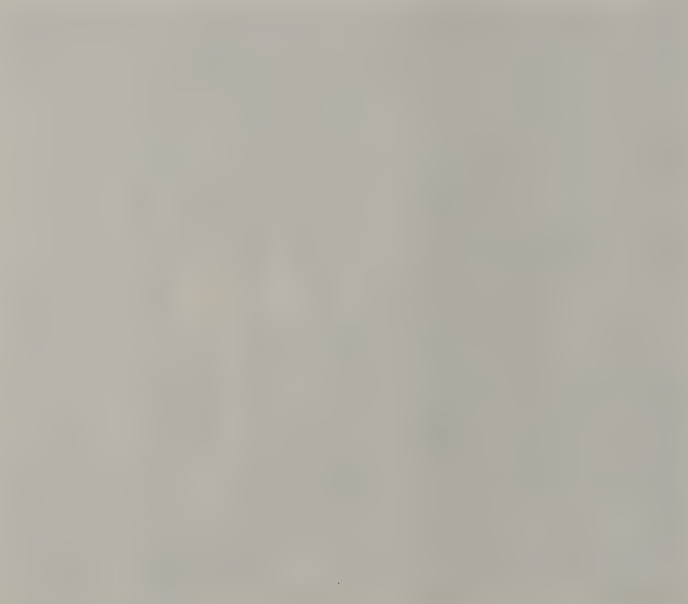
Figure 21

Blower fans used for supplying fresh air to tunnel ventilation system. (Baltimore Harbor Tunnel, Maryland).

Figure 22

Carbon monoxide analyzers and recorders (Lowry Hill Tunnel, Minnesota).





The fresh air is delivered to the roadway area at regular frequent intervals to insure a uniform distribution of air through the tunnel length. In the case of Alternate One the fresh air will pass through slots, or port openings, in the wall separating the fresh air duct from the tunnel roadways. In Alternate Two, flues leading from the overhead fresh air duct will carry the air down to roadway level. The air, after diluting the exhaust gases generated by traffic, will be drawn into the tunnel exhaust ducts through regularly spaced port openings in the walls (Alternate One) or in the tunnel ceiling (Alternate Two). The air will then be drawn through the tunnel exhaust ducts by the exhaust fans in the ventilation buildings and expelled into the outside atmosphere through high Evase stacks above the roof of the buildings.

The air quality in the tunnel will be constantly monitored by carbon monoxide analyzers and recorders located in each ventilation building (See Fig. 22). Samples of air will be continuously drawn into the analyzers where the carbon monoxide content is determined and recorded on a graph. Adjustable contacts within the analyzers will automatically adjust the fan operation (that is, the number of fans operating and the speed at which they are operating) to maintain the purity of the tunnel atmosphere. A manual override of automatic operation will be provided at the central control board.

Ventilation Buildings

The mechanical and electrical equipment will be housed in above-ground buildings located near each portal. The buildings are sized to enclose the equipment, with sufficient space provided for maintenance and servicing of the equipment. Because the project is situated on the aircraft approaches to Monroe County Airport, the building on the west end of the project must be limited in height. For economy of construction, both buildings in each alternate are made identical in size.

Buildings will be of fire proof, industrial type construction with an architectural treatment in keeping with the surrounding areas. For Alternate One buildings about 60 feet high, 66 feet long and 144 feet wide are required. For Alternate Two building dimensions are approximately 48 feet high, 155 feet long and 123 feet wide.

Tunnel Lighting

Each roadway has two continuous rows of fluorescent fixtures, one on each wall. Supplemental lighting inside the entrance portals increases the lighting intensity in these areas in order to reduce the optical shock of traveling from natural to artificial lighting. Lighting levels are automatically controlled by photoelectric cells located near each portal with manual overrides in the control board. Lighting fixtures are wired in a manner which will prevent a total black-out of the tunnel in the event of a failure in any circuit.

Tunnel Finish

A ceramic tile finish on the tunnel walls and ceiling will increase the brightness level and uniformity of the tunnel lighting system. This material provides a permanent surface which is relatively easy to clean and maintain.

Niches for traffic control equipment, fire alarms, fire extinguishers, emergency telephones and fire valves are spaced at regular intervals in the tunnel walls. Splicing chambers for high tension electrical cables are located in the tunnel walls and sidewalk manholes are provided for low tension electrical conduits and ducts. To permit the use of wall cleaning machines, all niches are recessed in the walls and are provided with suitable frames and covers.

Electrical Installation

It is essential that the tunnel be adequately illuminated and ventilated at all times. In order to insure complete continuity of service, two separate and independent sources of electrical energy will be provided. It is assumed that realiability of service in the Rochester area will be such that emergency generating equipment will not be required and the cost of such equipment is not included in this estimate.

Transformers for reducing primary voltage to the needs of the tunnel equipment and capable of carrying the full power load, will be located in each ventilation building, with cross-tie cables in the tunnel. Separate switches and controls are provided for each fan unit, lighting circuit, drainage pump and their auxiliary systems. (See Fig. 23)

Figure 23

Transformers and switchgear in electrical system. (Hampton Roads Tunnel, Virginia).

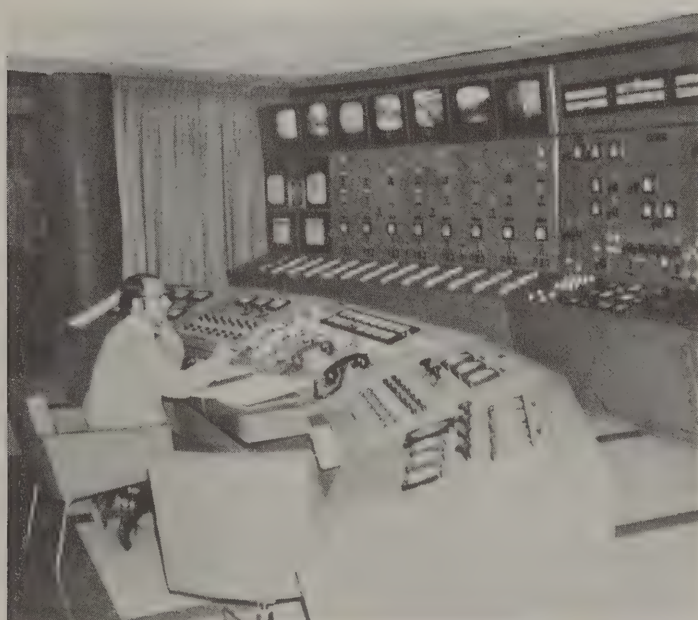


Figure 24

Central control room (Louis-Hippolyte Tunnel, Montreal, Canada).

Control Equipment

In order to minimize the number of operating personnel required at the tunnel, the latest in automatic equipment has been incorporated in the mechanical and electrical installations. In addition, a closed circuit television system will be installed to aid in tunnel traffic control and to locate emergency situations. The TV system, along with controls for the other equipment will be centralized in a control room, located in one of the ventilation buildings, from which one man can oversee the entire tunnel operation. A control room similar to, but less luxurious than, the one shown in Fig. 24 will be provided.

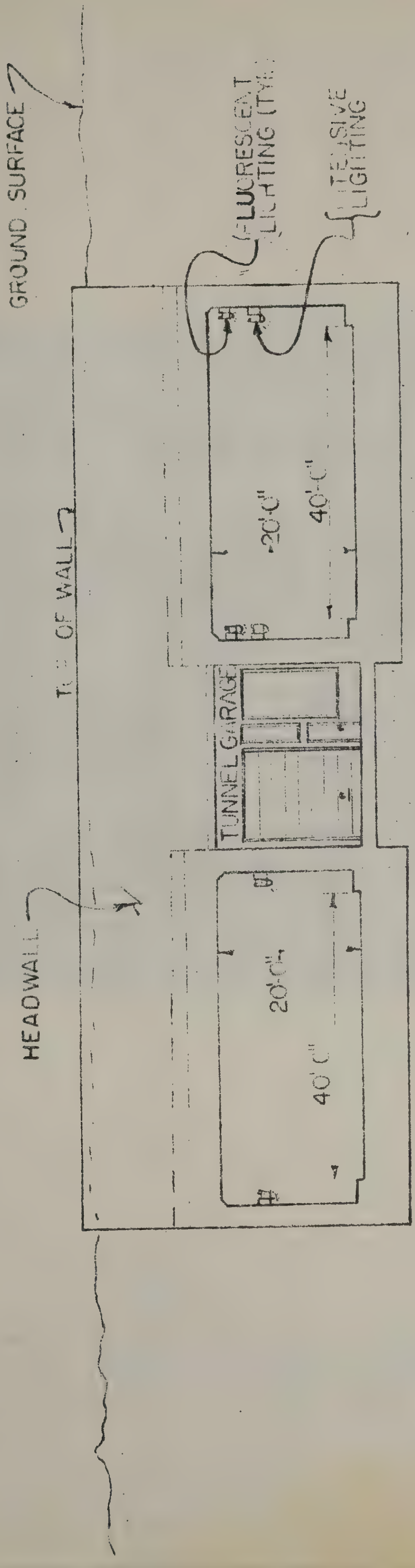
Fan units and pumps will be equipped with local controls which will permit isolation of the equipment for maintenance and servicing.

Emergency Equipment

Garages are provided at each end of the tunnel to house special emergency vehicles. In Alternate One the garages are located as close as practicable to the tunnel portals. Alternate Two allows the garages to be located between the tubes at each portal (Plate Thirteen). Both Alternates enable emergency vehicles to enter the tunnel "against traffic". These vehicles will be manned by trained individuals on an around-the-clock basis and the vehicles will be fully equipped to cope with any emergency situation (See Fig. 25).

GENESEE VALLEY PARK
ROCHESTER, NEW YORK

PLATE THIRTEEN



ALTERNATE TWO
PORTAL SECTION

Det. J. Campoli 5/21/73

Figure 25

Emergency vehicles (Baltimore Harbor Tunnel, Maryland). These special, short wheel-base vehicles were not equipped with fire fighting, first aid, rigging, and forcible entry equipment when photograph was taken.

The control room operator will be capable of summoning outside assistance (police, fire, or ambulance service) through direct telephone connections.

All equipment outages or malfunctions (overheating, overspeed, etc.) will trip alarms and/or signal lights on the control board. Equipment rooms will be provided with sprinkler or foam systems, fire alarms, fire extinguishers and telephone communications with the control room. Pump room sumps will be equipped with automatic foam systems to extinguish water borne petroleum fires and to prevent build-up of explosive gases. All pumping equipment will be explosion proof.

Motorists in distress can call for assistance from within the tunnel by using the communications facilities located in the niches described under "Tunnel Finish".

SECTION H.

This section contains an itemized breakdown of the quantities, prices and total amounts for the various items required in the construction of Alternates One and Two. It has been stated before in this report and it is reiterated here that the itemized costs, and hence the total costs, are absolute minimums. They are completely supportable, however, since the same item prices have been bid on similar projects elsewhere. When either of the alternates is constructed, it can be expected that many of the item prices will increase and that the total cost will be substantially higher. The reasons for this are as follows:

1. No attempt has been made to adjust the item prices geographically. Construction costs in the Rochester area are higher than average.
2. The factor used for inflation is low. The State generally uses a figure nearly twice that used in this estimate.
3. Optimistically favorable natural conditions were assumed.

It is, therefore, recommended that those who use these figures do so only with extreme caution and full realization that considerable upward adjustment in item costs and total cost will probably be necessary.

ALTERNATE ONE
ESTIMATED COST OF CONSTRUCTION

NO.	ITEM	UNIT	QUANTITY	PRICE	AMOUNT
	SITE PREPARATION AND MAINTENANCE				
1	Clearing and Grubbing	L.S.			24,000
3	Detours and Maintenance of Vehicular and Pedestrian Traffic	L.S.			100,000
4	Maintenance of Genesee River and Red Creek Flow	L.S.			3,324,490
5	Detours and Maintenance of Railroad Traffic	L.S.			60,000
6	Demolition of Existing Outer Loop Roadways and Structure	L.S.			72,000
	CUT & COVER TUNNEL STRUCTURE				
7	Open Cut Tunnel Excavation in Earth, including Sheeting, Bracing and Dewatering	C.Y.	1,278,000	5.00	6,390,000
8	Open Cut Tunnel Excavation in Rock, including Rock Reinforcement and Dewatering	C.Y.	283,210	4.50	1,274,445
9	Structural Concrete in Tunnel Invert Slab	C.Y.	125,400	45.00	5,643,000
10	Structural Concrete in Tunnel Walls and Roof	C.Y.	128,900	55.00	7,089,500
12	Protection Concrete and Working Slab Concrete	C.Y.	21,450	40.00	858,000
13	Reinforcing Bars and Wire Mesh	Lb.	55,150,000	.25	13,787,500
14	Four Ply Membrane Waterproofing	S.Y.	159,577	5.00	797,885
15	Copper Waterstops	Lb.	71,810	3.50	251,335
	OPEN DEPRESSED APPROACH STRUCTURES				
37	Earth Excavation, including Sheeting, Bracing and Dewatering	C.Y.	189,200	4.50	851,400

ROCHESTER OUTER LOOP
ALTERNATE ONE
ESTIMATED COST OF CONSTRUCTION

NO.	ITEM	UNIT	QUANTITY	PRICE	AMOUNT
39	Structural Concrete for Retaining Wall Structure and to Resist Bouyancy	C.Y.	24,463	50.00	1,223,150
40	Structural Concrete in Portal Pump Room Structures	C.Y.	2,360	50.00	118,000
41	Protection Concrete and Working Slab Concrete	C.Y.	4,000	40.00	160,000
42	Reinforcing Bars and Wire Mesh	Lb.	1,849,380	.25	462,345
43	Four Ply Membrane Waterproofing	S.Y.	17,100	5.00	85,500
44	Copper Waterstops	Lb.	11,320	3.50	39,620
	TUNNEL MECHANICAL AND ELECTRICAL WORK				
45	Roadway Manholes	Each	29	500.00	14,500
46	Catch Basins	Each	58	250.00	14,500
47	Iron Castings for Transverse	Lb.	62,000	.30	18,600
48	Steel Castings for Transverse Roadway Drains	Lb.	29,000	.35	10,150
49	8-inch Diameter Wrought Iron Discharge Pipe	L.F.	8,600	25.00	215,000
50	6-inch Diameter Wrought Iron Water Service Pipe	L.F.	8,600	18.00	154,800
51	4-inch Diameter Cast Iron Pipe Drains	L.F.	2,320	15.00	34,800
52	Copper Tubing Drains	Lb.	18,060	2.00	36,120
54	Miscellaneous Steel and Iron	Lb.	20,000	.50	10,000
55	Hydrants	Each	6	350.00	2,100
56	Pumping Equipment	L.S.			[illegible]5,000
57	Ventilating Fans, Motors and Transmissions	L.S.			1,100,000

ALTERNATE ONE
ESTIMATED COST OF CONSTRUCTION

NO.	ITEM	UNIT	QUANTITY	PRICE	AMOUNT
58	Sidewalk Manholes	Each	22	200.00	4,400
59	3' 1/2-inch Six-way Clay Duct	L.F.	8,600	6.00	51,600
60	1 1/2-inch Diameter Galvanized Steel	L.F.	51,600	3.00	154,800
61	2-inch Diameter Galvanized Steel Conduit	L.F.	8,600	3.50	30,100
62	4-inch Diameter Galvanized Steel Conduit	L.F.	25,800	8.00	206,400
63	2-inch Diameter Asbestos Cement Conduit	L.F.	8,600	2.00	17,200
64	4-inch Diameter Asbestos Cement Conduit	L.F.	17,200	3.00	51,600
65	Rare Copper Grounding Cable	L.F.	2,150	1.50	3,225
66	Galvanized Cast Iron Boxes	Lb.	12,900	2.00	25,800
67	Conduit Connections to Ventilation Buildings	L.S.			10,000
68	Electrical Wiring and Equipment	L.S.			3,250,000
	TUNNEL FINISH WORK				
69	Ceramic Glazed Wall Tile	S.F.	250,500	2.80	701,400
70	Ceramic Glazed Ceiling Tile	S.F.	362,400	2.50	906,000
71	Cement Mortar Ceiling Coves	L.F.	17,200	1.35	23,220
72	Cement Mortar Bases, including Gutters	L.F.	17,200	1.00	17,200
73	Wall-mounted Tunnel Handrails	L.F.	17,200	7.00	120,400
74	Painting of Tunnel Curbs	S.F.	12,900	.50	6,450
75	Monolithic Asbestos Cement Doors and Frames for Tunnel Niches	Each	144	700.00	100,800

ROCHESTER OUTER LOOP
ALTERNATE ONE
ESTIMATED COST OF CONSTRUCTION

NO.	ITEM	UNIT	QUANTITY	PRICE	AMOUNT
	BUILDINGS				
76	East Ventilation Building	L.S.			1,500,000
77	West Ventilation Building	L.S.			1,500,000
78	East Emergency Garage	L.S.			50,000
79	West Emergency Garage	L.S.			50,000
80	Six Bay Maintenance Building	L.S.			175,000
	SITE RESTORATION				
81	Reconstruction of Scottsville Road	L.S.			270,000
82	Restoration of Waterfront areas	L.S.			679,000
83	Reconstruction of Affected Portions of Outer Loop Roadways and Structures	L.S.			30,000
84	Landscaping	L.S.			105,000
	ACCESS ROADS AND INCIDENTAL WORK				
85	Access and Service Roadways	S.F.	77,500	.70	54,250
86	Concrete Sidewalks	S.F.	10,000	1.50	15,000
87	Storm Drainage System	L.S.			67,000
88	Fencing	L.F.	3,000	7.00	21,000
	EQUIPMENT-OPERATION & MAINTENANCE				
89	Heavy Duty Emergency Tow Vehicle	Each	3	45,000	[illegible]
90	Brush-Flush Cleaning Truck	Each	1	60,000	60,000
91	Carrier Cleaning and Relamping Truck	Each	1	30,000	30,000
92	Three Quarter Ton Pickup Truck	Each	1	2,700	2,700

ALTERNATE ONE

ESTIMATED COST OF CONSTRUCTION

NO.	ITEM	UNIT	QUANTITY	PRICE	AMOUNT
93	Suburban Wagon	Each	1	3,200	3,200
	SUBTOTAL				54,685,685
	10% CONTINGENCY				5,468,568
	TOTAL - 1969 PRICES				60,154,253
	ADJUSTMENT TO 1973 PRICES				15,880,723
	TOTAL				76,034,976

ROCHESTER OUTER LOOP
ALTERNATE TWO
ESTIMATED COST OF CONSTRUCTION

NO.	ITEM	UNIT	QUANTITY	PRICE	AMOUNT
	SITE PREPARATION AND MAINTENANCE				
1	Clearing and Grubbing	L.S.			4,000
2	Rock Portal Preparation	L.S.			100,000
3	Detours and Maintenance and Vehicular and Pedestrian Traffic	L.S.			100,000
6	Demolition of Existing Outer Loop Roadways and Structures				72,000
	CUT & COVER TUNNEL STRUCTURE				
7	Open Cut Tunnel Excavation In Earth, including Sheeting, Bracing and Dewatering	C.Y.	494,400	5.00	2,472,000
8	Open Cut Tunnel Excavation in Rock, including Rock Reinforcement and Dewatering	C.Y.	267,100	4.50	1,201,950
9	Structural Concrete in Tunnel Invert Slab	C.Y.	38,800	45.00	1,746,000
10	Structural Concrete in Tunnel Walls and Roof	C.Y.	46,510	55.00	2,558,050
11	Structural Concrete in Tunnel	C.Y.	6,070	75.00	455,250
12	Protection Concrete and Working Slab Concrete	C.Y.	8,365	40.00	334,600
13	Reinforcing Bars and Wire Mesh	Lb.	19,949,000	.25	4,987,250
14	Four Ply Membrane Waterproofing	S.Y.	65,506	5.00	327,530
15	Copper Waterstops	Lb.	14,432	3.50	50,512
16	Stainless Steel Ceiling Hanger Units	Each	354	300.00	106,200
17	Structural Steel Ceiling Supports	Lb.	138,770	.25	34,692
	DRIVEN ROCK TUNNEL STRUCTURE				
18	Tunnel Excavation	C.Y.	370,000	20.00	7,400,000

ROCHESTER OUTER LOOP
ALTERNATE TWO
ESTIMATED COST OF CONSTRUCTION

NO.	ITEM	UNIT	QUANTITY	PRICE	AMOUNT
19	Structural Steel Tunnel Supports	Lb.	13,533,600	.15	2,030,040
20	Structural Concrete in Tunnel Walls and Arches	C.Y.	64,600	50.00	3,230,000
21	Structural Concrete in Tunnel Roadway Slab	C.Y.	9,175	40.00	367,000
22	Structural Concrete in Tunnel Ceiling Slab	C.Y.	15,550	100.00	1,555,000
23	Reinforcing Bars and Wire Mesh	Lb.	10,719,000	.25	2,679,750
24	Dampproofing	S.Y.	38,160	1.50	57,240
25	Coarse Aggregate for Subgrade and Drainage in Tunnel	Ton	41,780	7.00	292,460
26	Stone Drains at base of Tunnel Walls	L.F.	14,920	4.00	59,680
27	Formed Open Joint Drains in Tunnel Walls and Arches	L.F.	15,890	1.00	15,890
28	15-inch Diameter Longitudinal Pipe Drains, including Concrete Cradle	L.F.	7,460	10.00	74,600
29	8-inch Diameter Transverse Pipe Drains, including Concrete Cradle	L.F.	7,460	7.00	52,220
30	Drilling Holes in Rock And Masonry	L.F.	298,400	.50	149,200
31	Copper Waterstops	Lb.	15,890	3.50	55,615
32	Cement in Portland Cement Grout	Bbls.	17,480	35.00	611,800
33	Grouting Connections	Each	3,581	15.00	53,715
34	Steel Pipes for Grouting	Lb.	28,650	1.00	28,650
35	Stainless Steel Hanger Units	Each	746	300.00	223,800
36	Structural Steel Ceiling Supports	Lb.	292,440	.25	73,110
	OPEN DEPRESSED APPROACH STRUCTURES				
37	Earth Excavation, including Sheeting Bracing and Dewatering	C.Y.	306,400	4.50	1,378,800

ROCHESTER OUTER LOOP
ALTERNATE TWO
ESTIMATED COST OF CONSTRUCTION

NO.	ITEM	UNIT	QUANTITY	PRICE	AMOUNT
38	Rock Excavation, including Rock Reinforcement and Dewatering	C.Y.	7,640	4.00	30,560
39	Structural Concrete for Retaining Wall Structure and to Resist Buoyancy	C.Y.	50,400	50.00	2,520,000
40	Structural Concrete in Portal Pump Room Structures	C.Y.	2,360	50.00	118,000
41	Protection Concrete and Working Slab Concrete	C.Y.	6,300	40.00	252,000
42	Reinforcing Bars and Wire Mesh	Lb.	3,543,600	.25	885,900
43	Four Ply Membrane Waterproofing	S.Y.	26,950	5.00	134,750
44	Copper Waterstops	Lb.	35,420	3.50	123,970
	TUNNEL MECHANICAL AND ELECTRICAL WORK				
45	Roadway Manholes	Each	37	500.00	18,500
46	Catch Basins	Each	74	250.00	18,500
47	Iron Castings for Transverse Roadway Drains	Lb.	62,000	.30	18,600
48	Steel Castings for Transverse Roadway Drains	Lb.	29,000	.35	10,150
49	8-inch Diameter Wrought Iron Discharge Pipe	L.F.	11,000	25.00	275,000
50	6-inch Diameter Wrought Iron Water Service Pipe	L.F.	11,000	18.00	198,000
51	4-inch Diameter Cast Iron Pipe Drains	L.F.	2,960	15.00	44,400
52	Copper Tubing Drains	Lb.	23,100	2.00	46,200
53	Fresh Air Flues	Each	916	400.00	366,400
54	Miscellaneous Steel and Iron	Lb.	20,000	.50	10,000
55	Hydrants	Each	10	350.00	3,500

ROCHESTER OUTER LOOP
ALTERNATE TWO
ESTIMATED COST OF CONSTRUCTION

NO.	ITEM	UNIT	QUANTITY	PRICE	AMOUNT
56	Pumping Equipment	L.S.			50,000
57	Ventilating Fans, Motors and Transmissions	L.S.			1,400,000
58	Sidewalk Manholes	Each	28	200.00	5,600
59	3 1/2-inch Six-way Clay Duct	L.F.	11,000	6.00	66,000
60	1 1/2-inch Diameter Galvanized Steel Conduit	L.F.	66,000	3.00	198,000
61	2-inch Diameter Galvanized Steel Conduit	L.F.	11,000	3.50	38,500
62	4-inch Diameter Galvanized Steel Conduit	L.F.	33,000	8.00	264,000
63	2-inch Diameter Asbestos Cement Conduit	L.F.	11,000	2.00	22,000
64	4-inch Diameter Asbestos Cement Conduit	L.F.	22,000	3.00	66,000
65	Bare Copper Grounding Cable	L.F.	2,750	1.50	4,125
66	Galvanized Cast Iron Boxes	Lb.	16,500	2.00	33,000
67	Conduit Connections to Ventilation Buildings	L.S.			10,000
68	Electrical Wiring and Equipment	L.S.			4,000,000
	TUNNEL FINISH WORK				
69	Ceramic Glazed Wall Tile	S.F.	320,100	2.80	896,280
70	Ceramic Glazed Ceiling Tile	S.F.	458,380	2.50	1,145,950
71	Cement Mortar Ceiling Coves	L.F.	22,000	1.35	29,700
72	Cement Mortar Bases, including Gutters	L.F.	22,000	1.00	22,000
73	Wall-mounted Tunnel Handrails	L.F.	22,000	7.00	154,000
74	Painting of Tunnel Curbs	S.F.	16,500	.50	8,250

ROCHESTER OUTER LOOP
ALTERNATE TWO
ESTIMATED COST OF CONSTRUCTION

NO.	ITEM	UNIT	QUANTITY	PRICE	AMOUNT
75	Monolithic Asbestos Cement Doors and Frames for Tunnel Niches	Each	184	700.00	128,800
	BUILDINGS				
76	East Ventilation Building	L.S.			2,500,500
77	West Ventilation Building	L.S.			2,500,500
78	East Emergency Garage	L.S.			50,000
79	West Emergency Garage	L.S.			50,000
80	Six Bay Maintenance Building	L.S.			175,000
	SITE RESTORATION				
81	Reconstruction of Scottsville Road				270,000
83	Reconstruction of Affection Portions of Outer Loop Roadways and Structures	L.S.			90,000
84	Landscaping	L.S.			40,000
	ACCESS ROADS AND INCIDENTAL WORK				
85	Access and Service Roadways	S.F.	51,000	.70	35,700
86	Concrete Sidewalks	S.F.	10,000	1.50	15,000
87	Storm Drainage System	L.S.			67,000
88	Fencing	L.F.	3,000	7.00	21,000
	EQUIPMENT-OPERATION & MAINTENANCE				
89	Heavy Duty Emergency Tow Vehicle	Each	3	45,000	135,000
90	Brush-Flush Cleaning Truck	Each	1	60,000	60,000
91	Carrier Cleaning and Relamping Truck	Each	1	30,000	30,000
92	Three Quarter Ton Pickup Truck	Each	1	2,700	2,700

ROCHESTER OUTER LOOP
ALTERNATE TWO
ESTIMATED COST OF CONSTRUCTION

NO.	ITEM	UNIT	QUANTITY	PRICE	AMOUNT
93	Suburban Wagon	Each	1	3,200	3,200
	SUBTOTAL				54,600,839
	10% CONTINGENCY				5,460,084
	TOTAL - 1969 PRICES				60,060,923
	ADJUSTMENT TO 1973 PRICES				15,856,084
	TOTAL				75,917,007

I. TUNNEL OPERATION AND MAINTENANCE COSTS

The total estimated costs outlined in Section H. include the latest in labor saving traffic control and safety devices, however, efficient safe operation and maintenance of either Alternate requires a staff of both permanent and part time personnel. Materials and supplies, the major of which is electrical power, are also required. The following pages summarize the major categories of necessary annual expenditure and then break the major categories down item by item.

The breakdown of costs includes the absolute minimum number of personnel required for the operation of either alternate. The staffing patterns will probably change and the number of personnel be increased as the operational problems peculiar to either of the alternates become known.

The estimate for operation and maintenance does not include provisions for salting, sanding, and removal of snow from the open sections on the ends of both alternates. It is assumed that this work will be accomplished by regular State highway crews. The estimate also does not include police patrol of the tunnels. It is assumed that these duties will be handled by the law enforcement units patroling the area where the tunnels are located.

Although maintenance and operation costs for Alternates Three and Four were not broken out, it is assumed that they will approximate the figures estimated for Alternates One and Two.

SUMMARY

Estimated Annual Tunnel Maintenance and Operating Expenses

ALTERNATE ONE

Maintenance Personnel	$ 45,243
Maintenance Materials and Supplies	9,600
Operating Personnel	280,047
Operating Materials and Supplies	90,820
TOTAL	$ 425,710

ALTERNATE TWO

Maintenance Personnel	$ 54,421
Maintenance Materials and Supplies	12,200
Operating Personnel	280,047
Operating Materials and Supplies	111,700
TOTAL	$ 458,368

BREAK-DOWN OF

ESTIMATED ANNUAL TUNNEL MAINTENANCE

AND OPERATING EXPENSES

Alternate One: Cut & Cover Tunnel, 4,300 ft. long, portal to portal

Maintenance Expenses:

Personnel

2 Ventilation and electrical mechanics (8 hours daily 2@	$ 9,831		$ 19,662
1 Laborer (8 hours daily) 1@	7,061		7,061
2 Electricians (8 hours weekly) 2@	11,009 x 0.20		4,404
1 Laborer Foreman (4 hours weekly) 1@	8,518 x 0.10		852
4 Laborers (4 hours weekly) 4@	7,061 x 0.10		2,824
		Subtotal	$ 34,803
Plus 10% of Subtotal for Relief			3,480
Plus 20% of Subtotal for Fringe Benefits insurance, etc.			6,960
Total Maintenance Personnel			$ 45,243

Materials and Supplies

Relamping (2,500 @ $2.00)	$ 5,000
Gasoline (1,000 gals. @ $0.35)	350
Lub. Oil (100 gals. @ $1.20)	120
Fuel Oil for heating (10,000 gals @ $0.12)	1,200
Equipment Lubricants	200
Water for tunnel cleaning, etc.	1,400

Detergents for tunnel washing	$	860
Repairs and replacements		400
Miscellaneous expendable items		70
Total maintenance materials and supplies	$	9,600

Operating Expenses:

Personnel

1 Tunnel Supervisor (8 hours daily) 1@ $ 17,796		$ 17,796
1 Tunnel Operator (24 hours daily) 1@ $ 14,480 x 4.5*		55,160
4 Wrecker Crewmen (16 hours daily) 4@ $ 10,750 x 3.0*		129,000
2 Wrecker Crewmen (8 hours daily) 2@ $ 10,750 x 1.5		32,250
	Subtotal	$ 234,206
Plus 20% of Subtotal for Fringe Benefits, insurance, etc.		46,841
Total Operating Personnel		$ 280,047

* Factor to account for vacations, sick leave, etc. in order to maintain manning of post for more than one 8 hour shift.

Materials and Supplies

Electrical Power		
Lighting, controls and auxiliaries	3,000,000	KWH
Ventilation	755,000	KWH
	3,755,000	KWH
3,755,000 KWH @ $0.024	$ 90,120	
Telephone and miscellaneous services	550	
Expendable materials	150	
Total operating materials and supplies	$ 90,820	

BREAK-DOWN OF

ESTIMATED ANNUAL TUNNEL MAINTENANCE

AND OPERATING EXPENSES

Alternate Two: Driven and Cut & Cover Tunnel, 5,500 ft. long, portal to portal

Maintenance Expenses:

Personnel

2 Ventilation and electrical mechanics (8 hours daily) 2@ $ 9,831	$ 19,662
2 Laborers (8 hours daily) 2@ $ 7,061	14,122
2 Electricians (8 hours weekly) 2@ $11,009 x 0.20	4,404
1 Laborer Foreman (4 hours weekly) 1@ $ 8,518 x 0.10	851
4 Laborers (4 hours weekly) 4@ $ 7,061 x 0.10	2,824
Subtotal	$ 41,863
Plus 10% of Subtotal for Relief	4,186
Plus 20% of Subtotal for Fringe Benefits insurance, etc.	8,372
Total Maintenance Personnel	$ 54,421

Materials and Supplies

Relamping (3,100 @ $2.00)	$ 6,200
Gasoline (1,100 gals. @ $0.35)	385
Lub. Oil (100 gals. @ $1.20)	120
Fuel Oil for heating (14,000 gals. @ $0.12)	1,680
Equipment Lubricants	300
Water for tunnel cleaning, etc.	1,800

Detergents for tunnel washing	$ 1,100	
Repairs and replacements	525	
Miscellaneous expendable items	90	
Total maintenance materials and supplies	$ 12,200	

Operating Expenses:

Personnel

1 Tunnel Supervisor (8 hours daily) 1@ $ 17,796	$ 17,796	
1 Tunnel Operator (24 hours daily) 1@ $14,480 x 4.5*	55,160	
4 Wrecker Crewmen (16 hours daily) 4@ $10,750 x 3.0*	129,000	
2 Wrecker Crewmen (8 hours daily)	32,250	
Subtotal	$ 234,206	
Plus 20% of Subtotal for Fringe Benefits, insurance, etc.	46,841	
Total Operating Personnel	$ 280,047	

* Factor to account for vacations, sick leave, etc. in order to maintain manning of post for more than one 8 hour shift.

Materials and Supplies

Electrical Power		
Lighting, controls and auxiliaries	3,700,000	KWH
Ventilation	925,000	KWH
	4,625,000	KWH
4,625,000 KWH @ $0.024	$ 111,000	
Telephone and miscellaneous services	550	
Expendable materials	150	
Total operating materials and supplies	$ 111,700	

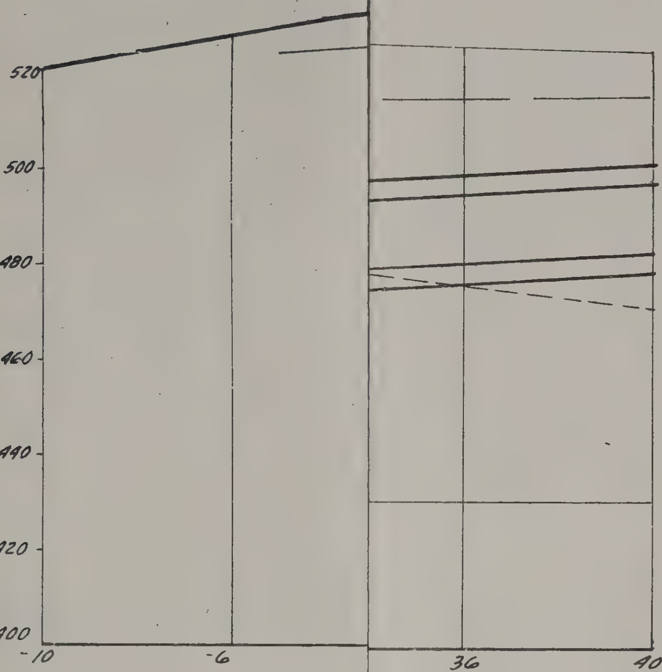
J. ALTERNATES THREE AND FOUR

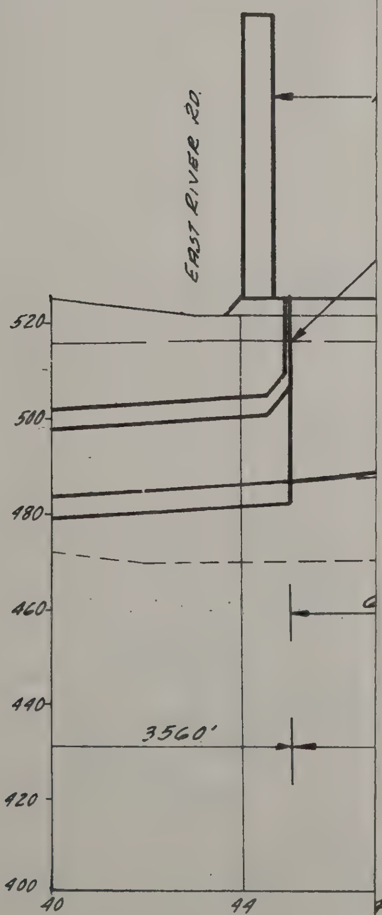
As stated in Section A, only Alternates One and Two were studied in detail. In order to arrive at appropriate cost figures, preliminary design of those alternates was undertaken. It is assumed, due to a minimal amount of subsurface information available, and to allow for a timely completion of this study, that the preliminary design for Alternates Three and Four can be eliminated and that the costs of these alternates could be estimated on a pro-rated linear foot basis when compared to Alternates One and Two. The same design criteria and the same tunnel and depressed roadway sections that were assumed for Alternates One and Two are assumed for Alternates Three and Four.

As can be seen on Plate Fourteen, Alternate Three, a cut and cover tunnel, yields a portal to portal installation of 3560 feet. This compares with a portal to portal installation of 4300 feet and results in a decrease of 740 feet or 17 percent. The estimated cost of Alternate Three is $63,109,030. Alternate Four, a driven rock tunnel with cut and cover sections on each end (See Plate Fifteen), yields a portal to portal installation of 4900 feet. This compares with a portal to portal installation of 5500 feet and results in a decrease of 600 feet or 11 percent. The estimated cost of Alternate Four

FED. ROAD REG. NO.	STATE	FEDERAL AID PROJECT NO.	SHEET NO.	TOTAL SHEETS
1	N.Y.			

ROCHESTER OUTER LOOP
SCOTTSVILLE RD. TO LEHIGH VALLEY RAILROAD
CUT & COVER TUNNEL (SOUTH ALTERNATE)
P.I.N. 4040.20



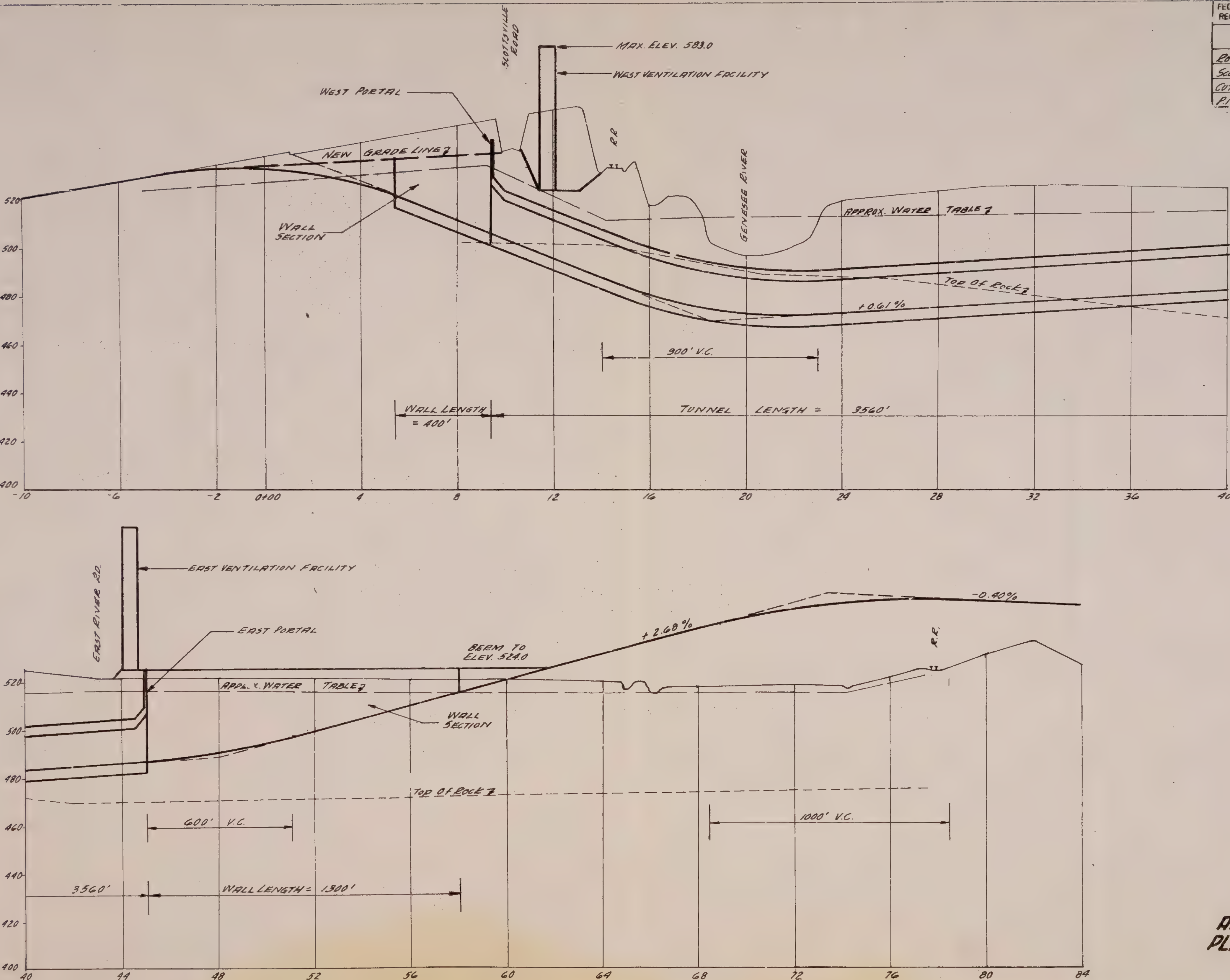


ALTERNATE THREE
PLATE FOURTEEN
PAGE 71

IN CHARGE OF ____ DESIGNED BY ____ DATED ____ CHECKED BY ____ DATED ____ REVIEWED BY ____ DATED ____

FED. ROAD REG. NO.	STATE	FEDERAL AID PROJECT NO	SHEET NO.	TOTAL SHEETS
1	N.Y.			

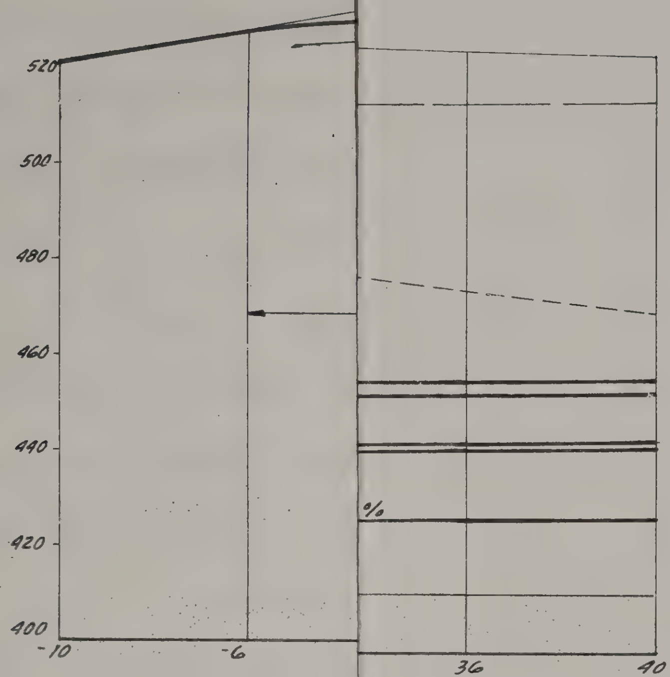
ROCHESTER OUTER LOOP
SCOTTSVILLE RD. TO LEHIGH VALLEY RAILROAD
CUT & COVER TUNNEL (SOUTH ALTERNATE)
P.I.N. 4040.20

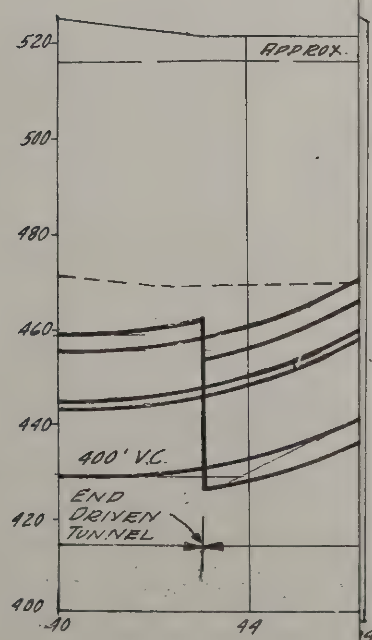


ALTERNATE THREE
PLATE FOURTEEN
PAGE 71

FED. ROAD REG. NO.	STATE	FEDERAL AID PROJECT NO.	SHEET NO.	TOTAL SHEETS
1	N.Y.			

ROCHESTER OUTER LOOP
SCOTTSVILLE RD. TO LEHIGH VALLEY RAILROAD
DRIVEN TUNNEL (SOUTH ALTERNATE)
P.I.N. 4040.20



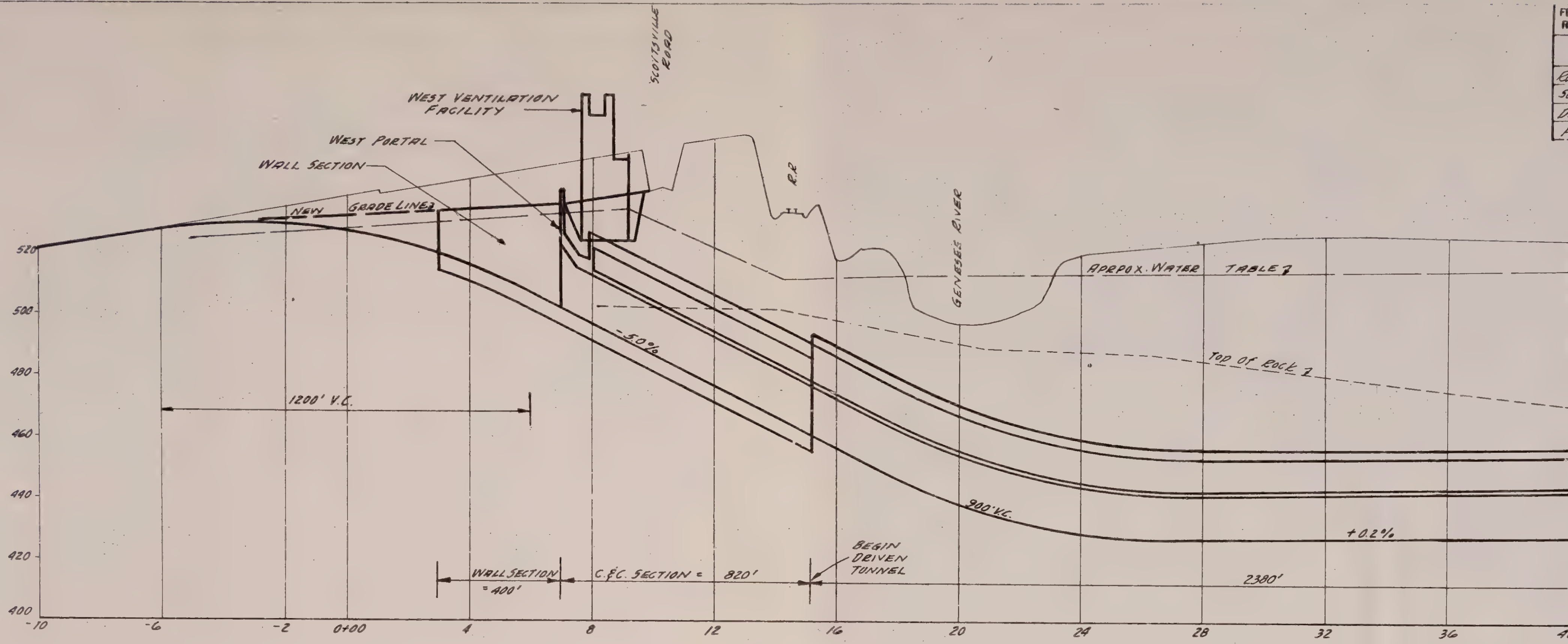


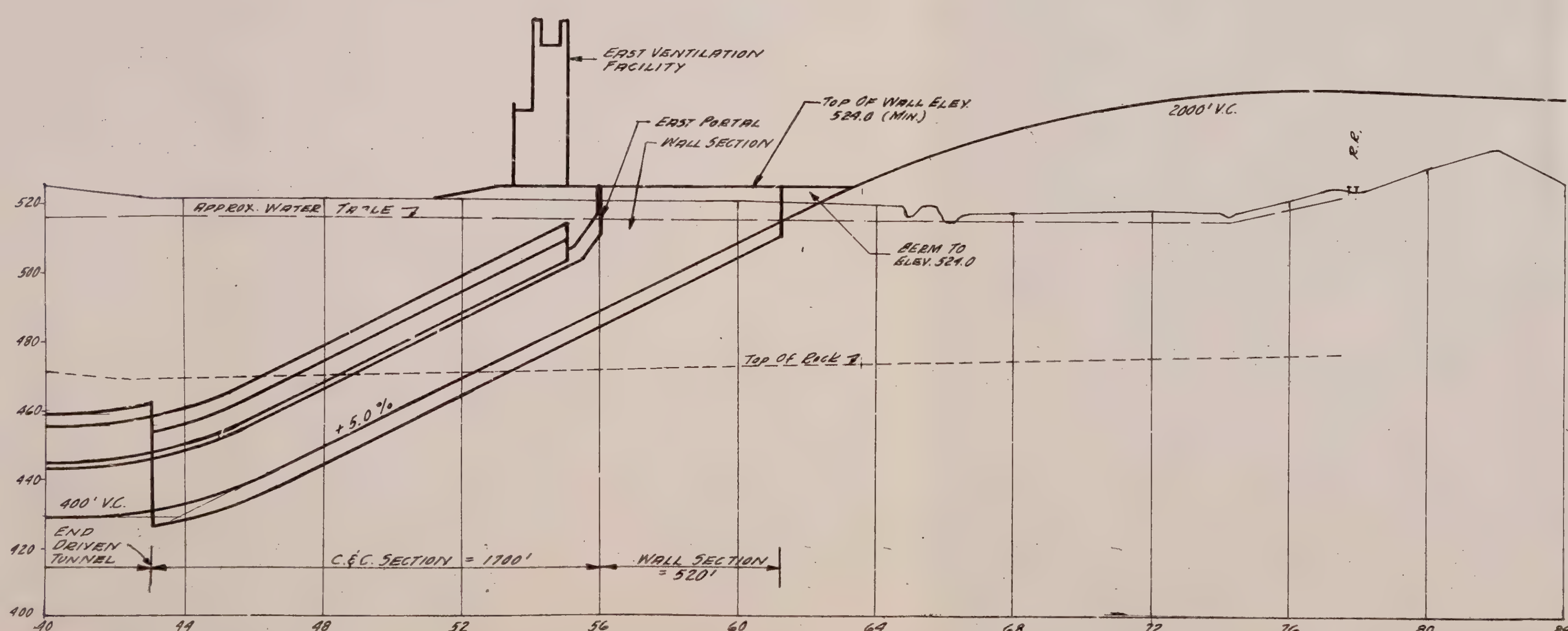
ALTERNATE FOUR
PLATE FIFTEEN
PAGE 72

IN CHARGE OF ____ DESIGNED BY ____ DATED ____ CHECKED BY ____ DATED ____ REVIEWED BY ____ DATED ____

FED. ROAD REG. NO.	STATE	FEDERAL AID PROJECT NO.	SHEET NO.	TOTAL SHEETS
1	N.Y.			

ROCHESTER OUTER LOOP
SCOTTSVILLE RD. TO LEHIGH VALLEY RAILROAD
DRIVEN TUNNEL (SOUTH ALTERNATE)
P.I.N. 4040.20





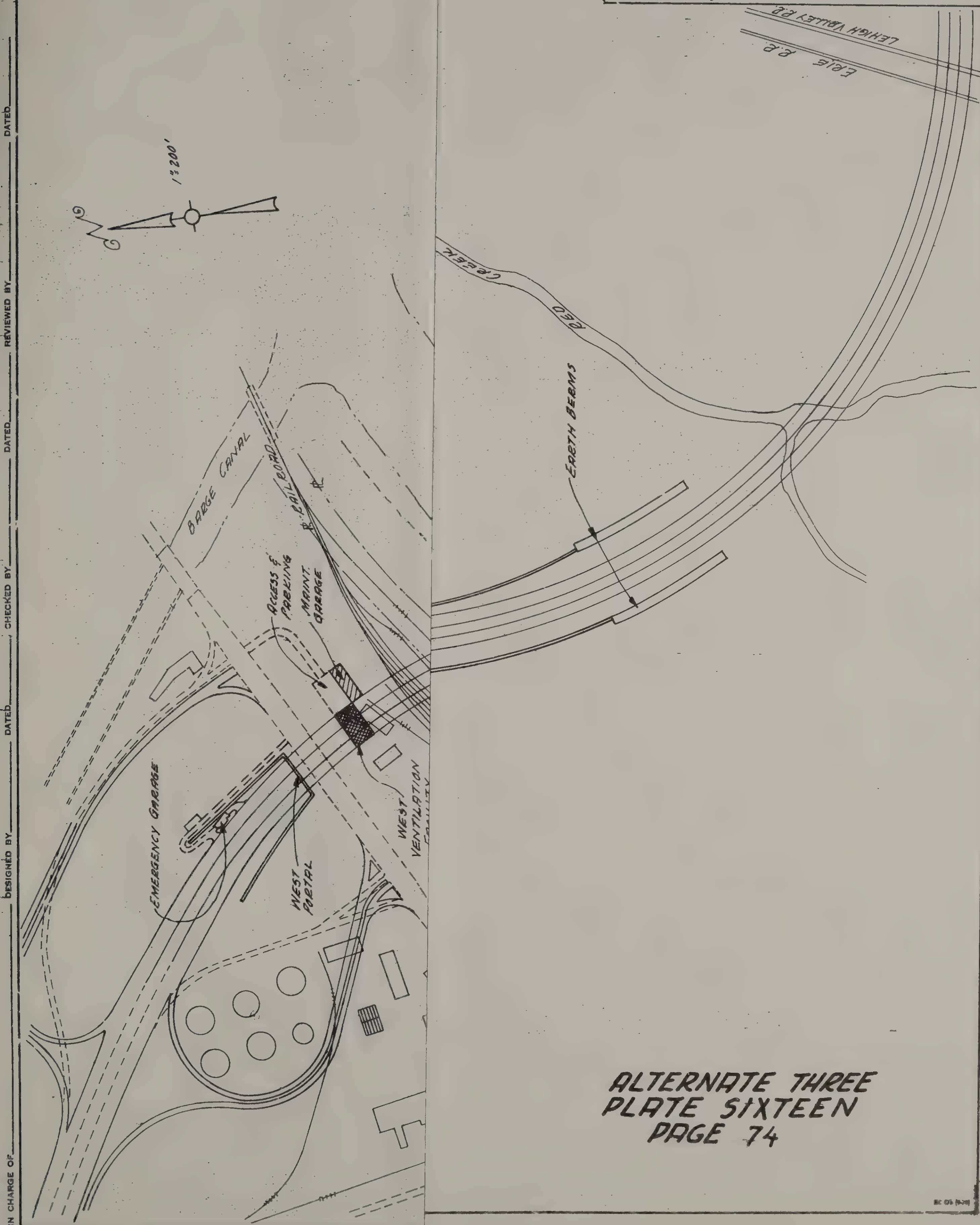
ALTERNATE FOUR
PLATE FIFTEEN
PAGE 72

if $67,647,136. The line chosen for Alternates Three and Four is shown on Plates Sixteen and Seventeen respectively.

Since both Alternates Three and Four portal just south of East River Road and are in open section for some distance in Genesee Valley Park, consideration was given to tunnel alternates which would portal outside of the park and east of the Lehigh Valley Railroad. Assuming the same conditions and methods utilized in arriving at estimated costs for Alternates Three and Four, a cut and cover tunnel through the park on Alternate Route B would cost $121,655,994. The cost of a driven tunnel along the same route is estimated at $101,222,676. Because of the high costs involved, and because the park land south of East River Road is largely undeveloped, it appears that either Alternate Three or Four is preferable to a tunnel which portals beyond the park boundaries.

FED. ROAD REG. NO.	STATE	FEDERAL AID PROJECT NO.	SHEET NO.	TOTAL SHEETS
1	N.Y.			

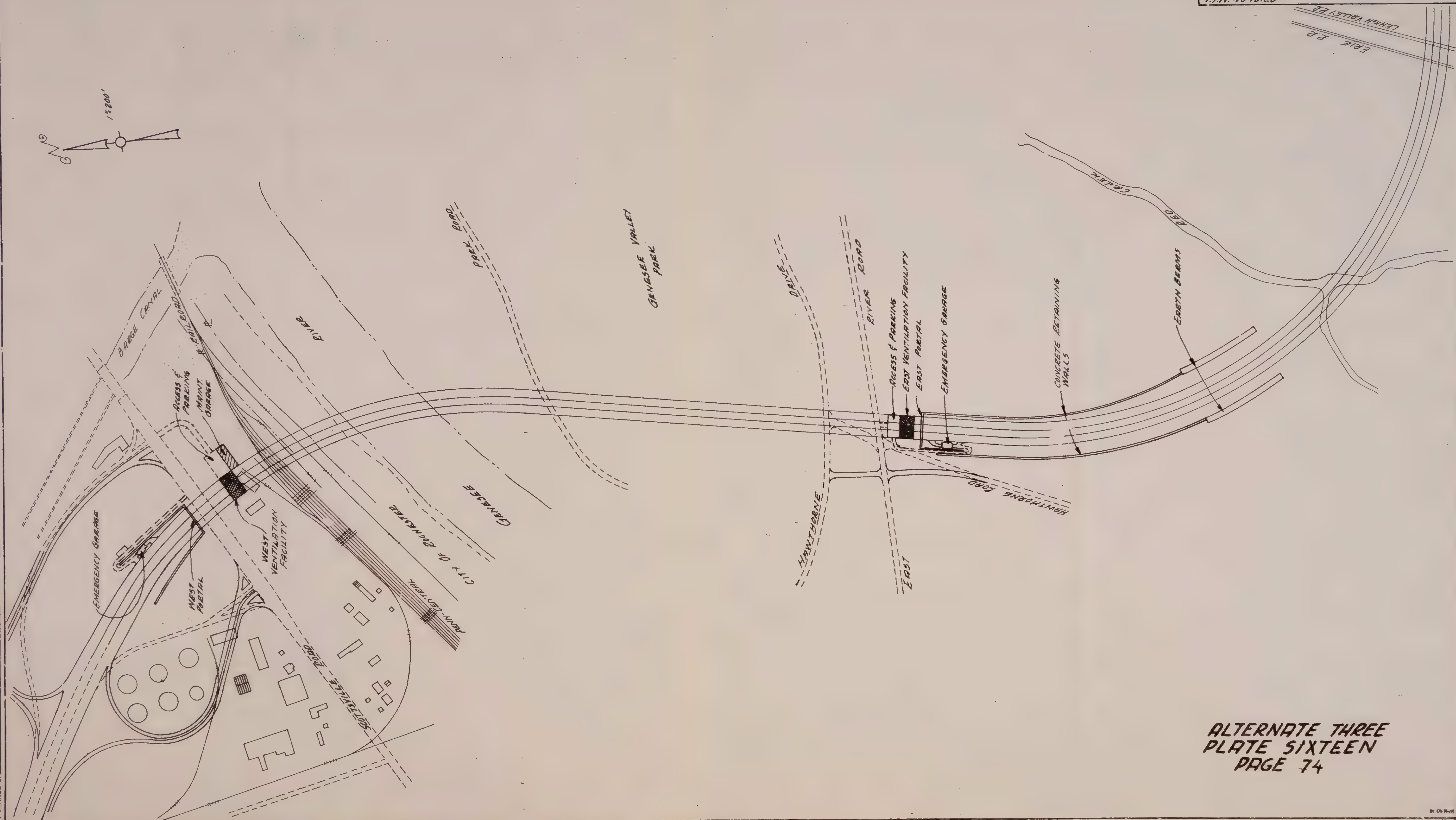
ROCHESTER OUTER LOOP
SCOTTSVILLE RD. TO LEHIGH VALLEY RAILROAD
CUT & COVER TUNNEL (SOUTH ALTERNATE)
P.I.N. 4040.20



ALTERNATE THREE
PLATE SIXTEEN
PAGE 74

FED. ROAD REG. NO.	STATE	FEDERAL AID PROJECT NO.	SHEET NO.	TOTAL SHEETS
1	N.Y.			

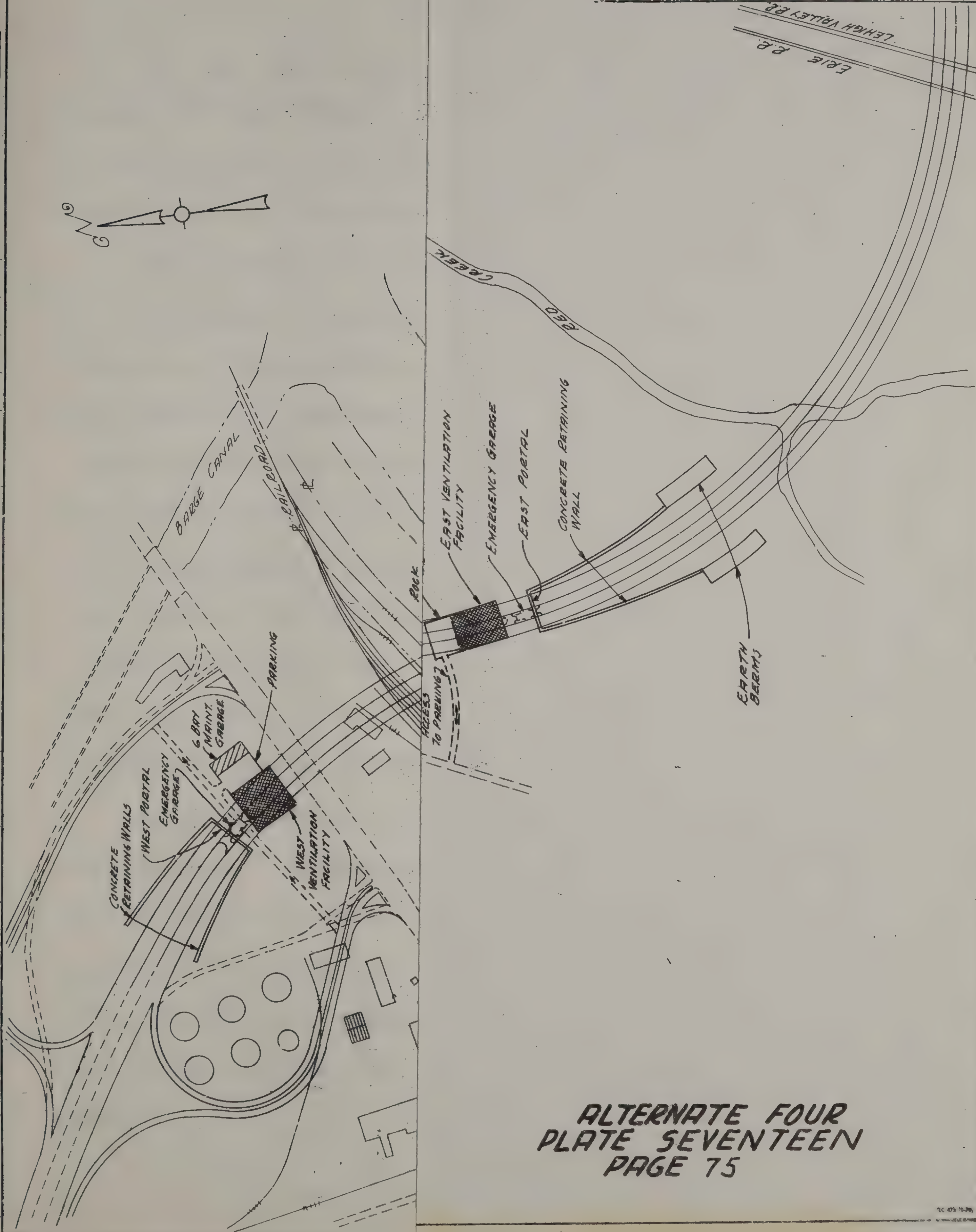
ROCHESTER OUTER LOOP
SCOTTSVILLE RD. TO LEHIGH VALLEY RAILROAD
CUT & COVER TUNNEL (SOUTH ALTERNATE)
P.I.N. 4040.20



ALTERNATE THREE
PLATE SIXTEEN
PAGE 74

FED. ROAD REG. NO.	STATE	FEDERAL AID PROJECT NO.	SHEET NO.	TOTAL SHEETS
1	N.Y.			

ROCHESTER OUTER LOOP
SCOTTSVILLE RD. TO LEHIGH VALLEY RAILROAD
DRIVEN TUNNEL (SOUTH ALTERNATE)
P.I.N. 4040.20

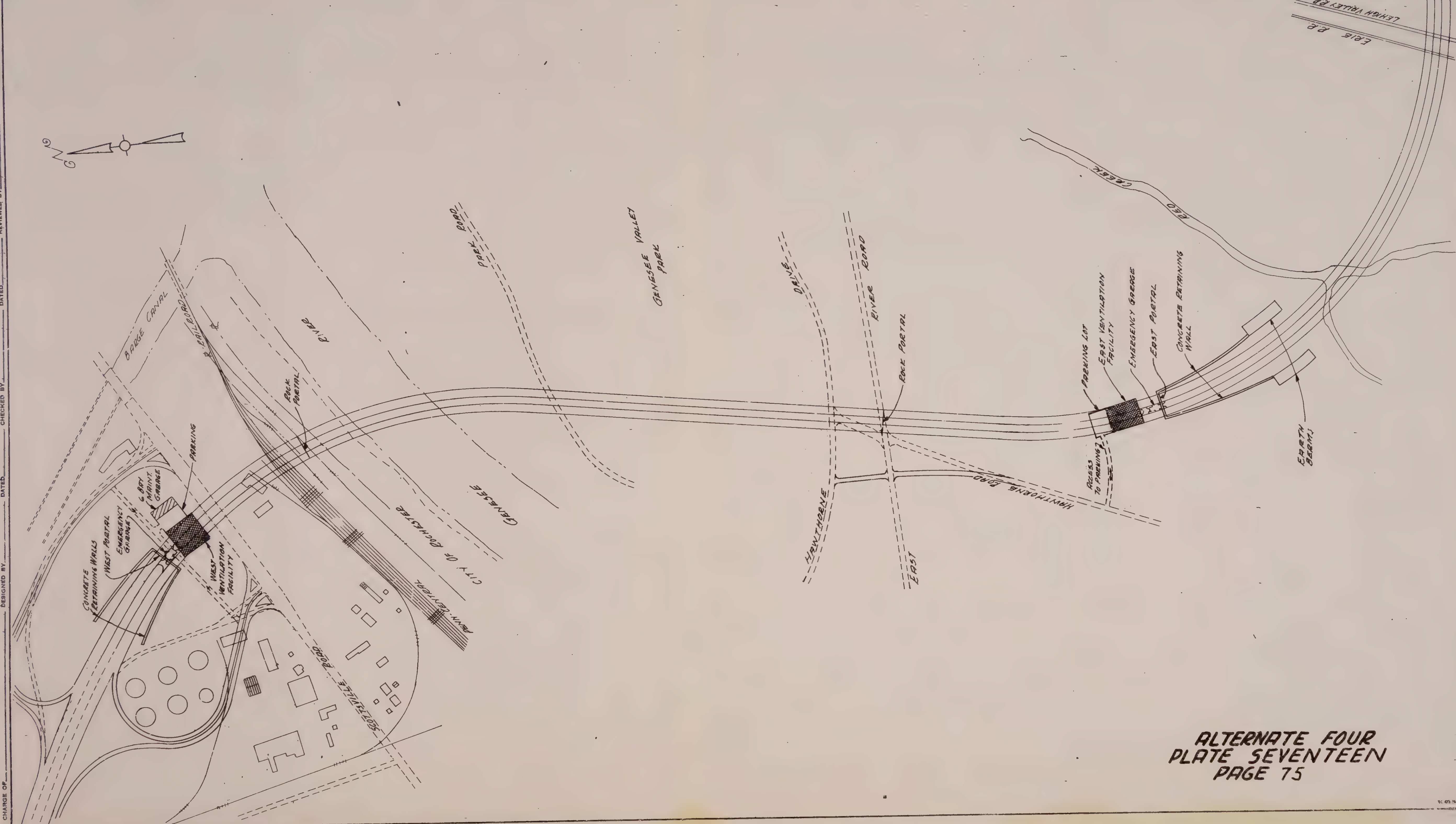


ALTERNATE FOUR
PLATE SEVENTEEN
PAGE 75

IN CHARGE OF ___ DESIGNED BY ___ DATED ___ CHECKED BY ___ DATED ___ REVIEWED BY ___ DATED ___

FED. ROAD REG. NO.	STATE	FEDERAL AID PROJECT NO.	SHEET NO.	TOTAL SHEETS
1	N.Y.			

ROCHESTER OUTER LOOP
SCOTTSVILLE RD. TO LEHIGH VALLEY RAILROAD
DRIVEN TUNNEL (SOUTH ALTERNATE)
P.I.N. 4040.20



ALTERNATE FOUR
PLATE SEVENTEEN
PAGE 75

K. DISCUSSION OF RESULTS

All four tunnel alternates require the acquisition of additional right-of-way. In the vicinity of Scottsville Road a tank farm must be acquired at an estimated cost of $4,000,000. This figure was not included in the tunnel estimates.

The minimum construction time for any of the alternates is 36 to 40 months. This time could be doubled or tripled if rock problems or dewatering problems are encountered. Alternate One will result in a temporary loss of a green and tee on the golf course and will take approximately 600 mature trees. Alternate Three will involve fewer trees but will disrupt a major part of the golf course. Alternate Two does no damage to the park, and Alternate Four disrupts only that portion of the park south of East River Road. This land is not developed at present. Alternates Three and Four will have exposed roadway on Genesee Valley Park land for 3300 feet and 2400 feet respectively.

All alternates will require storage and disposed of excavated material. Alternates One and Three will require storage of material for a minimum of 30 months on park land. The area necessary for storage will be approximately twice the width of the cut and cover excavation. Alternates Three and Four will restrict future flood control of the Red Creek drainage basin.

Prior to the construction of Alternates One or Two, the Brighton Sewer District No. 1 would necessarily be phased out. Either of these alternates also precludes the construction of a planned bus transfer station between the Outer Loop and the proposed rapid transit system.

During the construction of either Alternate One or Two, it will be necessary for the University of Rochester's Nuclear Center to cease operations. A portion of this structure is founded on end bearing piles and the rest is supported on a floating slab. The entire facility is extremely sensitive to vibration and changes in ground water levels. Vibration from blasting and movement of heavy equipment and changes in the water table level accompany the construction of both alternates.

The Barge Canal is located directly adjacent to Alternate One and the eastern cut and cover portion of Alternate Two. To keep the canal in operation and canal water out of the cut and cover excavation will require considerable sheeting. The contractor will necessarily exercise extreme caution in this area.

Alternate Two necessitates a major redesign of the West Henrietta Road interchange and requires an eastbound Outer Loop motorist to travel an additional half mile to make the connection. This alternate also requires an eastbound Outer

Loop motorist to travel a distance in excess of a mile in order to gain access to Genesee Valley Park.

The design of the west ventilation building presented somewhat of a problem in that the height of the building had to conform with flight line clearance requirements for Monroe County Airport. Had the requirements allowed another 20 feet or so in height, the duct work could have been improved considerally. Even though the minimum requirements have been met, a building of this height and at the location required is undesirable.

The speed limit on the Outer Loop is presently 65 miles per hour. Because the tunnel section for all of the alternates has no shoulders and because driving in a tunnel is an infrequent and unfamiliar experience to most motorists, the speed limit in the tunnel section must be reduced to 50 to 55 miles per hour initially and may be lowered as operational problems mentioned later in this section become known. Vehicles carrying explosives and certain chemicals, gasses and fuels must be excluded from entry to any tunnel. These vehicles will necessarily utilize city streets to bypass the section of the Outer Loop containing the tunnel.

Severe operational problems exist with all alternates in the vicinity of the west portal and the Scottsville Road Interchange and are as follows:

1. Signing in tunnels has been previously attempted and all efforts have proved unsuccessful. The last sign available to a westbound motorist desiring to exit the Loop at Scottsville Road will be east of the tunnel facility, a mile or more from the interchange.

2. The Federal Highway Administration recommends that no portion of any interchange be located closer than 1000 feet to the portal of a vehicular tunnel. All four alternates are substandard in this respect. The portals for Alternates Two and Four have been widened so that westbound traffic can begin deceleration within the tunnel.

3. Steep grades (5 percent) will severely affect the speed of truck traffic. The slow moving vehicles will naturally occupy the right lane of the tunnel. Westbound traffic desiring to exit at Scottsville Road will have to either follow the slow moving trucks in order to exit or pass slow moving traffic and hope to break across traffic in the right hand lane at the exit. This appears to be a dangerous situation.

4. Eastbound traffic entering the Loop from Scottsville Road must accelerate, merge with eastbound Loop traffic, and enter the tunnel at the same time. Entering a tunnel alone is

4. a difficult enough experience for most people without having to cope with acceleration and traffic at the same time. A situation such as this is bound to be a source of accidents.

Although the operational problems exist, each of the tunnel alternates is considered workable. During the design of the alternates the Scottsville Road interchange was completely redesigned to reduce the hazards to traffic. Elimination of the operational problems is impossible unless the Scottsville Road interchange can be eliminated.